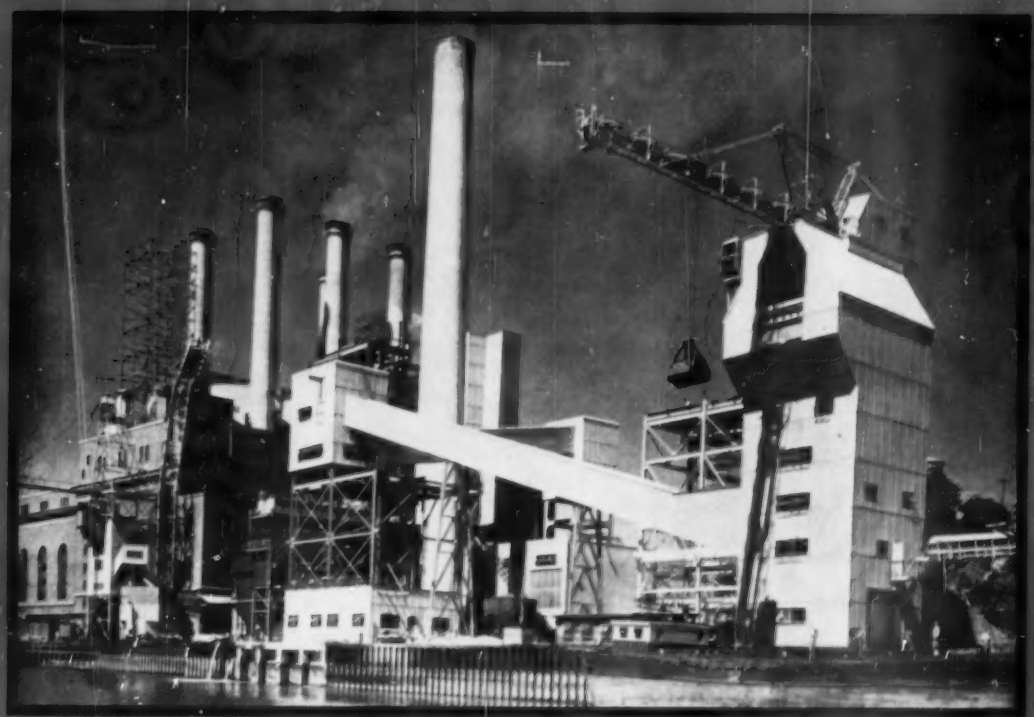
COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

June 1955



Coal unloading dock with 300-ton unloader, foreground, at the Glenwood Station, Long Island Lighting Co.

Traveling Grates Find a New Field

The Cost of Steam-Electric Power

The Dual-Cycle Boiling Reactor

Problems and Opportunities In Electric Utility Engineering

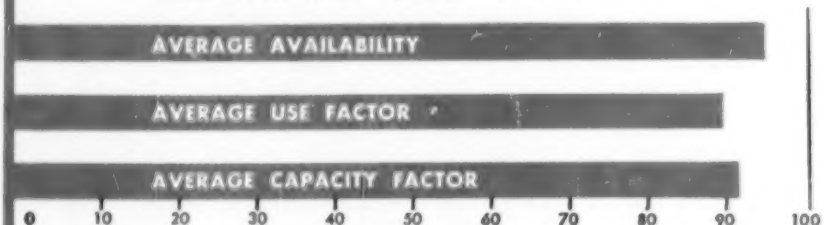
A look at the Record...

"ON THE LINE" PERFORMANCE of 76 C-E Reheat Boilers

There are 158 C-E Postwar Reheat Boilers in service, under construction or on order. These boilers represent an aggregate capacity of 18,473,000 kilowatts...an average of 117,000 kw per unit.

The first of these boilers was placed in service in September, 1949. By the end of 1954, seventy-six units were "on the line." The combined service of these 76 units represents a period equivalent to 129 boiler years. Significant data concerning them are summarized below.

Total Capacity — kw	7,670,000
Average Capacity per Unit — kw	101,000
Total Boiler Time — hours	1,130,040
Total Boiler Time — years	129



AVERAGE AVAILABILITY	96.35%
AVERAGE USE FACTOR	91.9%
AVERAGE CAPACITY FACTOR	93.9%

DISTRIBUTION OF TOTAL OUTAGE	PERCENT
Inspection	2.25%
Boiler • Superheater • Reheater Economizer • Air Heater • Desuperheater • Fuel Burning Equipment	0.83%
(Auxiliary Equipment) Valves • Fans • Soot Blowers • Miscellaneous	0.57%
TOTAL	3.65%

B-836

C-E

COMBUSTION ENGINEERING

Combustion Engineering Building, 200 Madison Avenue, New York 16, N. Y.

BOILERS, FUEL BURNING & RELATED EQUIPMENT; PULVERIZERS, AIR SEPARATORS & FLASH DRYING SYSTEMS; PRESSURE VESSELS; AUTOMATIC WATER HEATERS; SOIL PIPE

COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

Vol. 26 **No. 12**

June 1955

Feature Articles

Traveling Grates Find a New Field of Usefulness ..... *by Viggo Westergaard* 40

The Cost of Steam Electric Power ..... *by H. E. Roberts* 47

The Dual Cycle Boiling Reactor 55

Problems and Opportunities in Electric Utility Engineering ..... *by Philip Sporn* 59

Michigan Central Modernizes Passenger Station Terminal ..... *by A. E. DeForest* 63

Editorials

Publishing Engineering Information 39

Wanted: A Centripetal Professional Force 39

Departments

Advertising Index 84-85

Annual Index 75

COMBUSTION publishes its annual index in the June issue and is indexed regularly by Engineering Index, Inc.

GERALD S. CARRICK
Business Manager

JOSEPH C. McCABE
Editor
GLENN R. FRYLING
Associate Editor

CARL G. UDELL
Circulation Manager

Published monthly by COMBUSTION PUBLISHING COMPANY, INC., 200 Madison Ave., New York 16
A SUBSIDIARY OF COMBUSTION ENGINEERING, INC.
Joseph V. Santry, Pres.; Charles McDonough, Vice-Pres.; Otto Strauss, Treas.; Irving B. Swigart, Secy.
COMBUSTION is sent gratis to engineers in the U. S. A. in charge of steam plants from 500 rated boiler horsepower up and to consulting engineers in this field. To others the subscription rate, including postage, is $4 in the United States, $5.50 in Canada and Latin America and $7 in other countries. Single copies: Domestic, 40 cents; Foreign, 40 cents plus postage. Copyright 1955 by Combustion Publishing Company, Inc. Publication Office, Easton, P. Issued the middle of the month of publication.
Acceptance under Sect.on 34.64, P.L. & R., authorized by United States Post Office.

BPA

Printed in U. S. A.

Hudson saves $480,000 a year burning coal the modern way

A decision to improve its power service opened many possible courses of action to Hudson Motor Division of American Motors Corp. Based on findings of consultants Boddy, Benjamin and Woodhouse, Inc., Hudson decided to modernize completely its coal-burning, steam, electrical and compressed air equipment.

Today, steam at Hudson is supplied by three new boilers instead of ten old ones. Other new equipment includes a coal-handling system, automatic combustion controls and automatic ash disposal system. Manpower needs in the boiler area have been cut from 14 to 10 and in the compressor area from 8 to 6. With a reliable power supply, Hudson is protected from service interruptions. And the reduced cost of operation resulting from the new equipment will pay off the original investment in six years, leaving an annual saving of $480,000 thereafter!

Investigate Your Fuel Costs

If you're planning to modernize your plant or build a new one—or if you are just interested in cutting fuel costs—find out how coal, burned the modern way, compares to other fuels. Why not talk to a consulting engineer or your nearest coal distributor. Their advice may save you thousands of dollars each year.

facts you should know about coal

Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar.

Automatic coal and ash handling systems can result in a virtually labor-free plant.

Coal is the safest fuel to store and use. No dust or smoke problems when coal is burned with modern equipment.

In most industrial areas, bituminous coal is the lowest-cost fuel available.

Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

NATIONAL COAL ASSOCIATION
Southern Building, Washington 5, D.C.

Ljungstrom® field engineers assure you of maximum return on your preheater investment

Your Air Preheater Corporation field engineer aims to visit your installation at least once a year. It's his job to give you the help and advice you need to assure you of maximum return on your Ljungstrom Air Preheater investment.

This field service is another factor in making the Ljungstrom the most economical heating surface on the modern boiler. And it helps explain why 7 out of 10 modern preheater installations are Ljungstroms.

Get all the details on the Ljungstrom Air Preheater. Why it cuts fuel costs . . . helps maintain higher boiler efficiencies . . . why it speeds cleaning and maintenance. You'll find all the details in the new, 38-page reference manual, "Ljungstrom Air Preheaters." Write for your free copy, today!

Advantages of the Ljungstrom Air Preheater

- Size for size, recovers more heat than any other type.
- Reduces fuel consumption. Permits use of lower-grade fuels. Increases boiler output and reliability.
- Eliminates cold spots . . . keeps corrosion to a minimum.
- Easier, faster to clean and maintain.
- Requires far less supporting steel and is quickly erected.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

Why buy welded bonnet valves that lack these CRANE features?

New 1500 and 2500 pound check patterns . . . screwed or socket welding ends; ½" to 2". Patented construction assures high disc lift, free flow and minimum pressure drop.

1500 and 2500 pound globe patterns...screwed or socket welding ends; ½" to 2".

1500 and 2500 pound angle patterns...screwed or socket welding ends; ½" to 2".

When you buy CRANE Lip-Seal Bonnet Valves . . . designed exclusively for high pressure/high temperature power plant service . . . you are assured of:

- lip-seal welds that are laid on flat surfaces—needn't be chipped out or burned out;
- easy dismantling and reassembly—bonnet screws out after weld is *ground away*—makes inside of valves entirely accessible;
- bonnet threads are chrome plated to prevent galling or seizing;
- stems that do not bind or gall—because of CRANE's exclusive ball-joint glands;
- easy access to stuffing box—swing-type gland eye-bolts swing free of yoke area, can't be lost;
- a more rigid swivel disc-stem connection that minimizes vibration;
- that each size valve is a separate design for proper proportion—another CRANE exclusive.

Specify "Crane Lip-Seal" when you want small valves for high pressure/high temperature steam service. For more reasons why you should do so, ask your CRANE representative for Circular AD1902, or write direct. CRANE CO., General Offices: 836 S. Michigan Ave., Chicago 5, Ill. Branches and Wholesalers Serving All Industrial Areas.

CRANE CO.

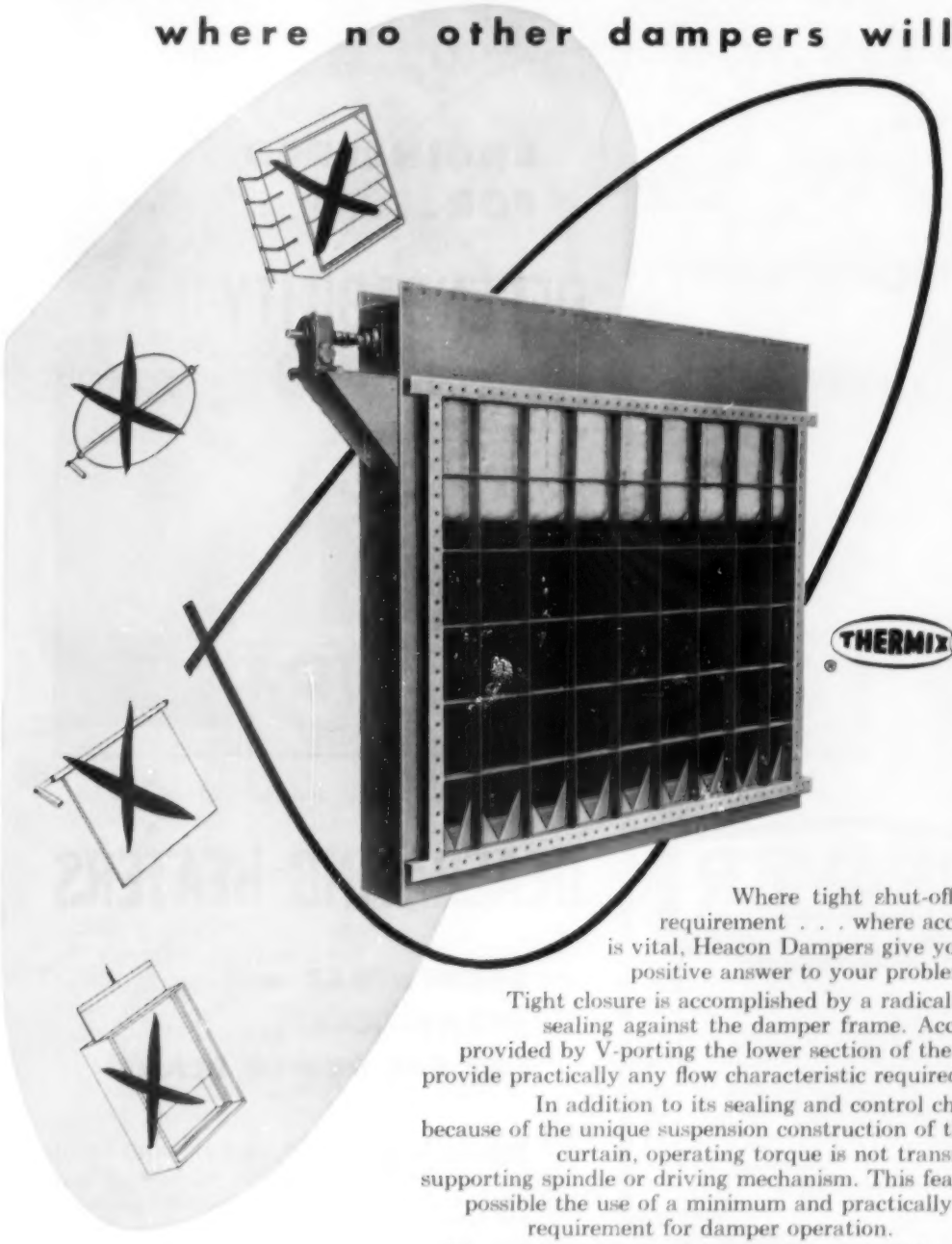
for the THRIFTY BUYER

VALVES • FITTINGS • PIPE
KITCHENS • PLUMBING • HEATING

CRANE'S FIRST CENTURY...1855-1955

THE FINEST DAMPER THAT MONEY CAN BUY

HEACON DAMPERS *are specified*
where no other dampers will work



Where tight shut-off is an absolute requirement . . . where accurate control is vital, Heacon Dampers give you the only positive answer to your problem.

Tight closure is accomplished by a radical method of sealing against the damper frame. Accurate control is provided by V-porting the lower section of the frame to provide practically any flow characteristic required.

In addition to its sealing and control characteristics, because of the unique suspension construction of the sealing curtain, operating torque is not transmitted to the supporting spindle or driving mechanism. This feature makes possible the use of a minimum and practically constant power requirement for damper operation.

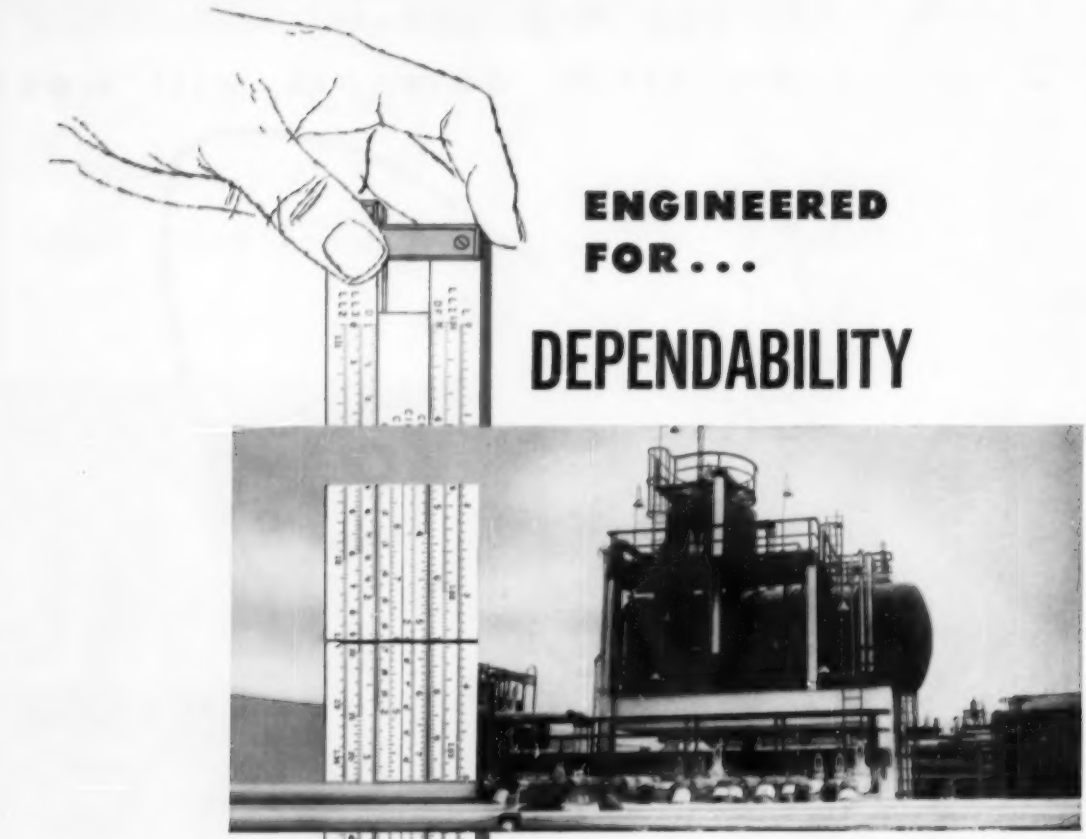
Thermix, Project Engineers for Heacon will be glad to help solve your damper problems. Why not contact them today

Project Engineers

THE THERMIX CORPORATION
GREENWICH, CONN.

(OFFICES IN 38 PRINCIPAL CITIES)

Canadian Affiliates: T. C. Chown, Ltd. 1440 St. Catherine St. W., Montreal 25, Quebec. 983 Bay St., Toronto 5, Ontario, Canada



ENGINEERED FOR . . .

DEPENDABILITY

GRAVER

DEAERATING HEATERS

SPRAY, TRAY and SPRAY-TRAY . . . FOR THE POWER PLANT

Write for: Articles T-114, T-115, T-117 and T-127
Spray Heater Bulletin WC-101A
Tray Heater Bulletin WC-106

Industrial Department: I-112

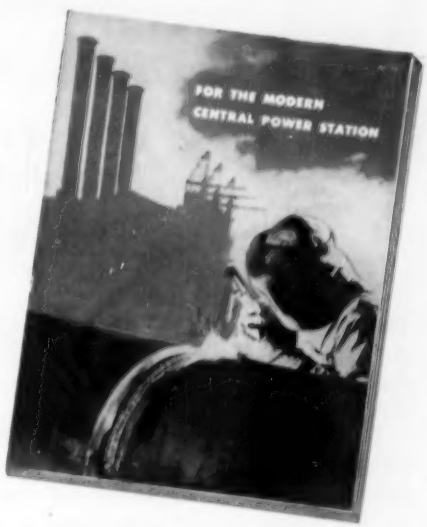
GRAVER WATER CONDITIONING CO.
A Division of Graver Tank & Mfg. Co., Inc.
216 West 14th Street, New York 11, N. Y.

M. W. KELLOGG WELDING TECHNIQUES KEEP PACE

As supercritical pressures and temperatures are put to work more and more in improving the economics of steam-electric plants, supercritical engineering and workmanship are demanded of the welding techniques for main and reheat steam piping.

At M. W. Kellogg, one of the many ways by which the company's power piping fabrication keeps pace with steam boiler and turbine designs is K-Weld* . . . a unique inert gas shielded arc welding technique that assures complete penetration and a highly uniform internal contour *without the use of backing rings.*

No welding problem in the shop or field is too tough for K-Weld. Developed through M. W. Kellogg's initial work on thin-walled stainless steel rockets, K-Weld safeguards the vital link between boilers and turbines in steam-electric central stations throughout the U.S. and Canada. Write for particulars. K-Weld's indicated uses in nuclear plant applications also warrant your investigation.

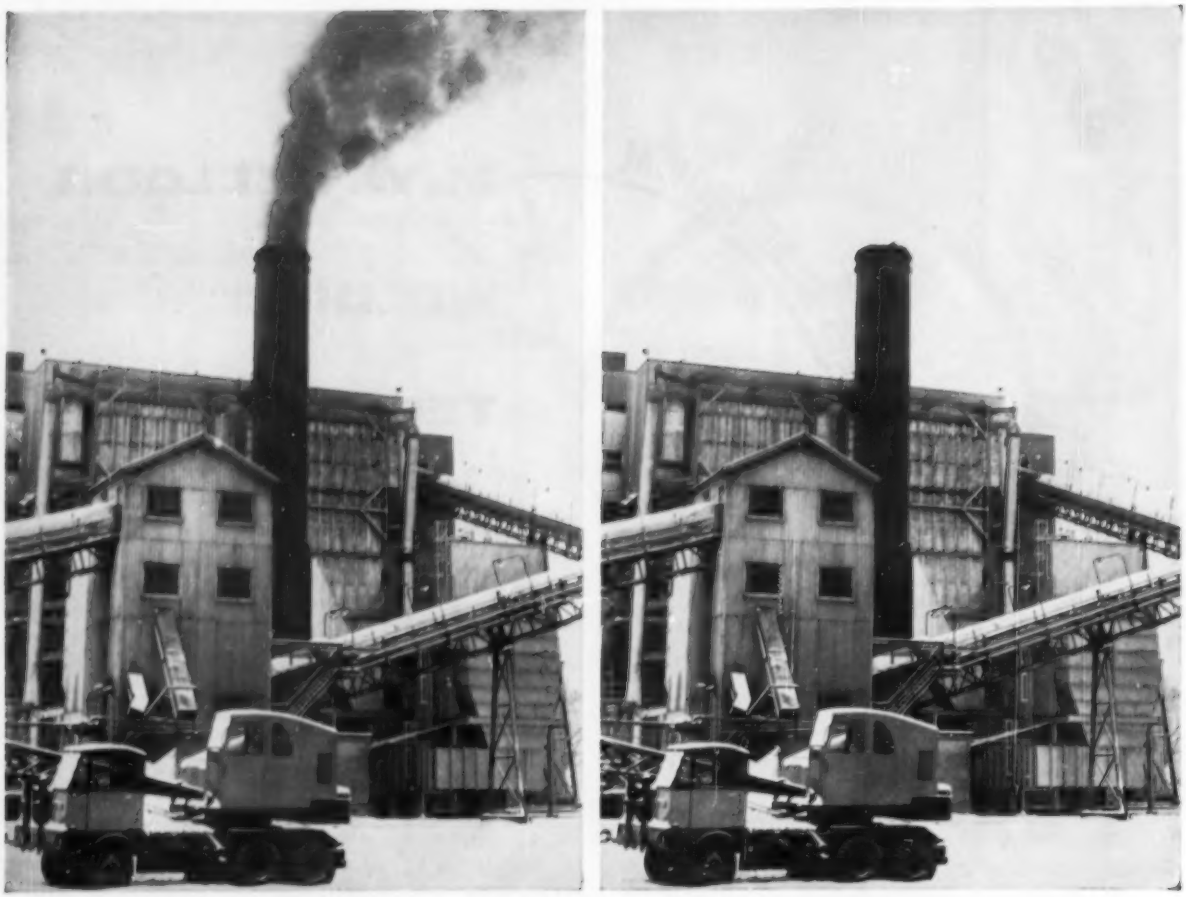


This 12-page booklet describes K-Weld in detail as well as M. W. Kellogg's other facilities for serving the power piping needs of modern central stations.

FABRICATED PRODUCTS DIVISION
THE M. W. KELLOGG COMPANY, 225 BROADWAY, NEW YORK 7, N.Y.
The Canadian Kellogg Company, Ltd., Toronto • Kellogg International Corporation, London
SUBSIDIARIES OF PULLMAN INCORPORATED

**Trademark of The M. W. Kellogg Company*

POWER PIPING—THE VITAL LINK



Fly Ash Problem Solved By Central Station

This Pennsylvania utility felt that as long as you can *see* dirty stack discharge, you have a problem. To solve it, they decided to insist on fly ash collection equipment with very high efficiency.

The electrical precipitators they chose, which were placed after existing mechanical collectors, are Cottrells, designed and built by Research-Cottrell. Their effectiveness is demonstrated in the above unretouched photographs. At the left, the precipitators were turned off long enough to take the picture showing the volume of fly ash discharged by the boilers. At the right, the precipitators are turned back on. Stack discharge is visually clean.

This is another example of industry's trend toward establishing its own higher standards for nuisance abatement. Research-Cottrell, which has made more fly ash installations than any other company, cites the following comparison:

In the period from 1923 to 1939 only 11% of its power plant customers specified fly ash collection efficiency of 95 to 98%. In recent years, that 11% has risen to fully 90%.

One reason, of course, is the generally increasing emphasis on community relations. Another factor is that far-sighted companies are anticipating stricter smoke regulations. They are anxious to install equipment that will end their smoke problems now and also prevent such problems from occurring in the future.

Still another factor is this. In recent years, with modern coal pulverization and advanced boiler design, there has been an increase in the fineness of fly ash particles. This calls for the most efficient equipment available.

Read—in Bulletins FA and MI—about Cottrell equipment and the Research-Cottrell's MI Rapper. This device eliminates rapping puffs and enables the precipitator to maintain, continuously, its high collection efficiency. Write for your copies today.

RC-193

RESEARCH-COTTRELL, INC.

A WHOLLY OWNED SUBSIDIARY OF RESEARCH CORPORATION

Main Office and Plant: Bound Brook, N. J.

405 Lexington Ave., New York 17, N. Y. • Grant Building, Pittsburgh 19, Pa.
228 N. La Salle St., Chicago 1, Ill. • 111 Sutter St., San Francisco 4, Cal.

Why does this packing outwear others in cold liquid service?
Because J-M NAVALON contains and retains more lubricant!
Johns-Manville
NAVALON PACKING

...and NAVALON® is made of Ramie, nature's strongest fibre

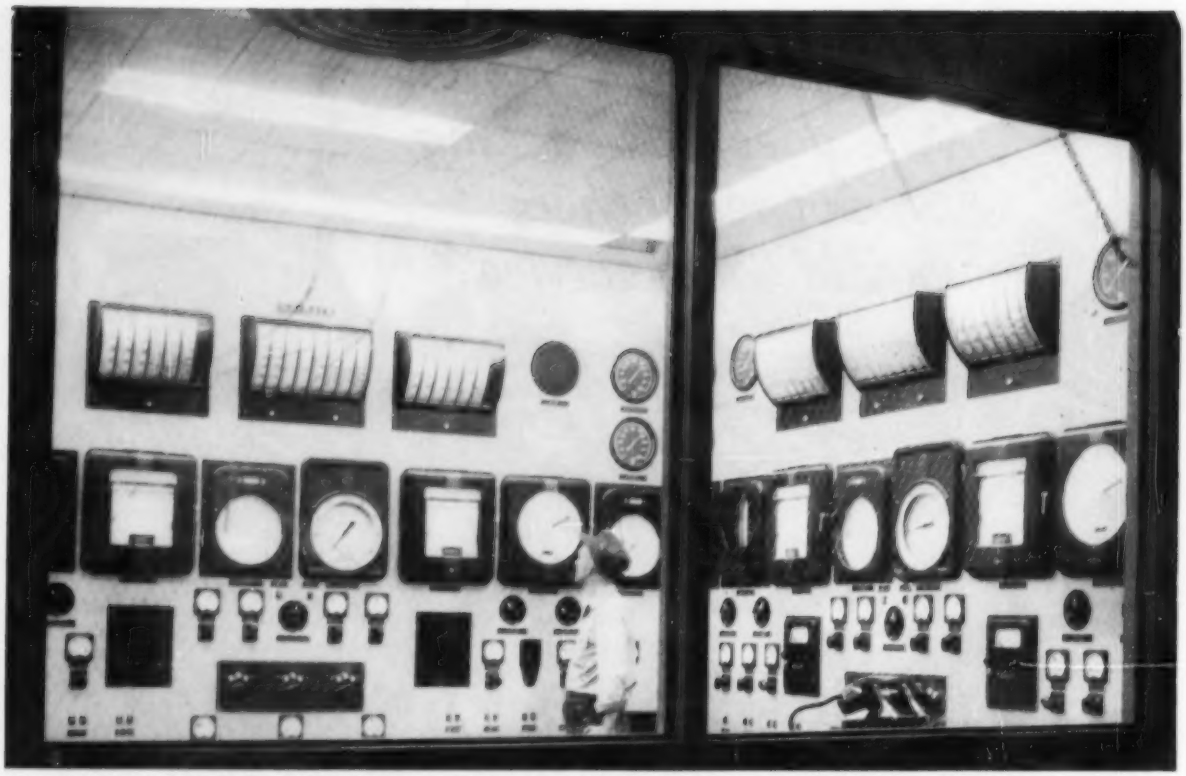
J-M Navalon gives more value because it outwears other high quality packings in cold liquid service. Made by an exclusive process, it contains more lubricant to start with and retains more lubricant in service . . . resulting in less wear on equipment and longer packing life. Navalon has other unique features, too. It resists rot and mildew . . . its strength actually increases when wet . . . the result: fewer shutdowns for repacking.

That's why Navalon is widely used to seal against fresh or salt water, brine, cold oils . . . and many other cold liquids. It has an excellent record of service on pumps, elevators, accumulators, reciprocating rods and plungers, stern tubes and rudder posts of ships. Available in full range of sizes, in styles 190 and 245 for industrial use, style 175 for marine use.

Your J-M Packing Distributor carries complete stocks of J-M Navalon and other high quality Johns-Manville Packings. He can help you choose the right one for your application. Call him for complete information or address Johns-Manville, Box 60, N.Y. 16, N.Y. In Canada, 199 Bay St., Toronto 1, Ont.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville PACKINGS & GASKETS



AIR CONDITIONED CONTROL ROOM ILLUSTRATES COMPLETE BOILER PLANT INSTRUMENTATION SUPPLIED BY HAYS.

MULTIPLE FUEL COMBUSTION CONTROL OF CYCLONE FURNACES

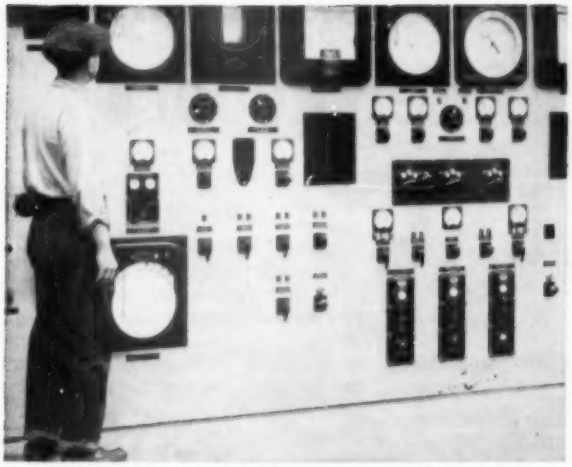
At Michigan City Station of Northern Indiana Public Service Co.*

Flexible, efficient, safe firing of *both* coal and gas in cyclone furnaces is being achieved at the Michigan City, Indiana generating station of NIPSCO* by means of an electric combustion control system designed and built by engineers of The Hays Corporation working closely with company officials and the consulting engineers, Sargent & Lundy.

The system permits any desired allocation of load among the three boilers, between the two cyclone furnaces of a given boiler and between the two fuels being burned simultaneously in a given cyclone. Thus, any conceivable load-need or fuel supply situation can be accommodated.

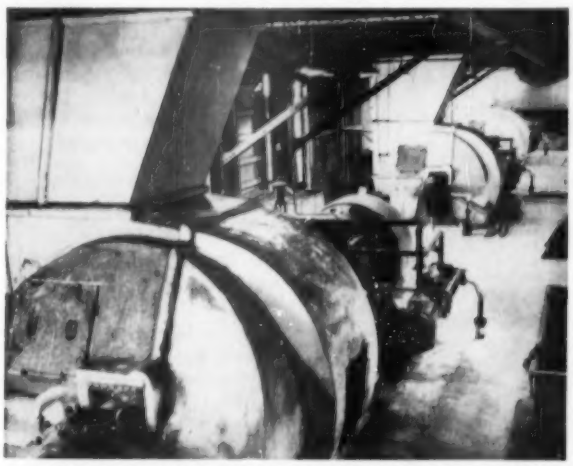
In addition, complete safety for the multi-million dollar installation is "built in" since each boiler is equipped with a system of mechanically and electrically interlocked selector switches arranged to require a definite sequence of operation in transferring from manual to automatic control and vice versa. For example, interlocks require that (1) the ID fan must be running (2) the ID fan damper must be partially open and (3) at least one of the FD fan duct dampers must be opened before the FD fan can be started.

This installation illustrates the care and ingenuity exercised by Hays engineers in solving the combustion control problems of boiler plant operators throughout the world—regardless of boiler size, fuels being burned, etc. Write for a free, fully illustrated, 8-page story on this central station —available from The Hays Corp., Michigan City, Indiana.

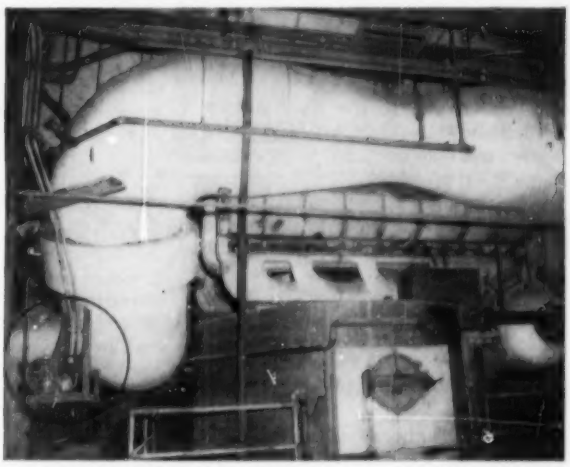


SPACE SAVING is achieved by mounting all position indicators, manual control stations, fuel-air ratio adjustments, and mechanical interlocks for one boiler inside control room

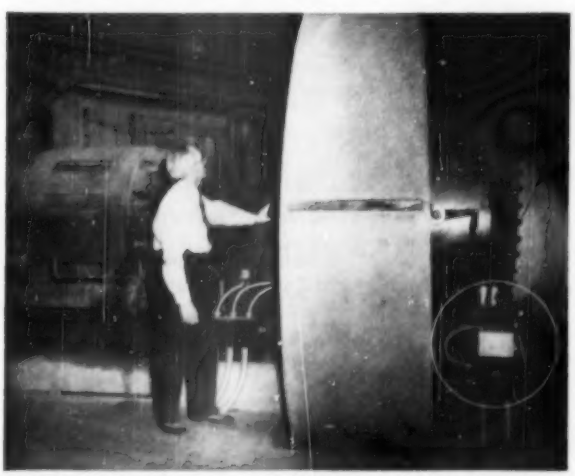
near related instruments for convenience of operator (*at left*); controllers themselves are grouped on outside wall of control room for ease of inspection and maintenance (*at right*).



CORRECT FURNACE DRAFT is maintained by controlling induced draft fan inlet damper as well as induced draft fan speed. Latter is accomplished by means of hydraulic coupling equipped with reversing oil pump.



HUGE VENTURI in forced draft duct provides means of accurately measuring air to individual cyclone. The Hays power unit *(indicated within circle)* operates a damper in this forced draft duct.



THREE 120,000 CFM, motor driven forced draft fans (one for each boiler) provide air for cyclones at 54" water pressure. Hays power unit (*circle*) adjusts forced draft fan inlet damper in response to forced draft duct pressure controller.

Automatic Combustion Control
Boiler Panels • Hays-Penn Flowmeters
Venturiflow Meters and Venturol
Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders
Electronic Oxygen Recorders

THE hays CORPORATION

MICHIGAN CITY 1, INDIANA

HALL LABORATORIES, INC.—A SUBSIDIARY OF HAGAN CORPORATION, PITTSBURGH, PENNSYLVANIA

Hall Industrial Water Report

VOLUME 3 JUNE 1955 NUMBER 3

It Takes a Lot of Water Conditioning To Manufacture Textiles

Wizardry in the research laboratories has created a new world of fabrics, but the finished cloth is still a product of the operating engineers' know-how. And they have to use water to put their know-how to work. A ton of rayon, for example, requires about 830 tons of water in its manufacture, while about 160 tons of water are needed to produce one ton of finished wool cloth.

That's why Hall Laboratories, as water engineering consultant, plays such a vital role in the manufacture of textiles.

High Water, Low Water

Variable flow in the river supply helped show the need for competent water management in a southern acetate rayon plant.

During one spring flood, plant operators battled for 48 hours to keep excessive solids down in the high-pressure boilers. Turbidity, silica and suspended material in the softener effluent kept climbing in spite of increased chemical feed and boiler water silica concentration rose to high levels in spite of higher blowdown.

At the height of the flood, the utilities engineer secured water samples throughout the system for study by Hall. Dissolved silica in the flood water was found to be low, but much of the suspended material was quartz. Analysis of the other samples showed that more and more of this crystalline silica had dissolved as the temperature and pH of the water increased in the softener and boilers.

With the help of Hall field engineer W. J. Reese plant personnel improved softener operation and set up procedures which would enable them to better handle the next flood.

Six months after the flood came a drought and a new problem. Because of the high solids dissolved in the river water, boiler water concentrations quickly became high enough to cause carryover. Working with the plant personnel, Reese was able to bring operations back to normal.

Now more precise control all through the water cycle guards against future critical periods.

Water Detectives Reduce Problem to Grease Spot

Rejection of cloth, valued by the manufacturer at $75.00 a yard, represented a serious loss to a woolen mill in the Great Lakes area. Brown stains were spotting the cloth in the last step of the finishing process where the wool was rolled on a perforated drum through which hot water was circulated to "crab" or set the fibers of the material.

Because the staining was first believed to be iron carried into the hot water lines by iron-fixing bacteria originating in the well water, the plant was considering the expenditure of several thousand dollars for the installation of equipment at each of three wells to kill off the "bugs." When Hall staff engineer H. A. Reda was called in to investigate the problem, he enlisted the aid of E. T. Laurin, Hall headquarters expert on textiles and textile processing. The combined work of Reda at the plant and Laurin in his lab brought out the fact that the "iron deposits" on the cloth were not iron at all but wool grease. This was being loosened from the cloth itself by the heat of the recirculated process water and was then redeposited even though the recirculated hot water passed through filter cloth. After the condition was recognized, more frequent changing of filter cloth minimized the difficulty.

In the course of the investigation, Reda uncovered other conditions which could lead to trouble. Recommendations were made to control corrosion in the softened hot water system with Calgon® and to set up proper water conditions in the boilers.

* * *

Textile manufacturing today demands the services of many specialists. The remarkable textiles available now would be non-existent without expert control of each production step. Hall Laboratories has kept pace with each development in textile technology, so that the industry could have full control of its most important raw material . . . water.

Supercritical Conditions Pose New Problems

Will there be new problems when water is used in the supercritical range for generation of power at 5000 psi and 1200 F? In a paper presented on April 4 at the Diamond Jubilee Mechanical Engineering Conference of the American Society of Mechanical Engineers, Dr. Everett P. Partridge, Director of Hall Laboratories, Inc., points out what may happen as a result of the increased solvent power of water as pressure and temperature go up. A limited number of multilith preprints are available on request.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information, write, wire or call Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

Water is your industry's most important raw material. Use it wisely.

Hall Laboratories, Inc.—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

What are the men doing?

They are retubing the fuel economizer.

What happened to the old tubes?

Sulphuric acid ate holes in them.

Who put sulphuric acid in the fuel economizer?

Well, nobody meant to. But there was too much sulphur in the coal and when the coal burned some of the sulphur was turned to sulphuric acid.

Why did they purchase the high sulphur coal?

It figured out cheaper on the cents-per-million-BTU basis.

But was it really cheaper by the time they put the new tubes in?

No, it wasn't! And this instance shows that BTU cost is not the only factor to be considered in buying fuel. It's a matter of matching fuel to use and to equipment, and that requires close cooperation between the plant engineer and the purchasing agent.

P.S.

There's a lot more to buying coal than the cost per ton. For facts and figures to solve your particular fuel requirements, write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake & Ohio Railway Company, Terminal Tower, Cleveland 1, Ohio.

Chesapeake and Ohio Railway

WORLD'S LARGEST CARRIER OF BITUMINOUS COAL

STAINLESS-CLAD STEEL DEFIES HANGUPS AND CORROSIVE WEAR

Two boilers at Salem Harbor Station are fed by stainless-clad steel bunker noses and pipes. No hangups or repairs have been reported in two years of operation.

In September 1952, the Salem Harbor Station of the New England Electric System went on the line. Rated as one of the most efficient stations in the nation, it has had two years of trouble-free operation. Stainless-clad steel figures directly in the exceptional performance of the interior coal handling equipment. No hangups or maintenance problems have occurred.

At Salem Harbor, stainless-clad was used at every point of extreme wear. The corrosive and abrasive effects of wet coal were virtually eliminated at key points. Four bunker noses and feed pipes were made of 3/8" stainless-clad, hoppers used 5/16" and 1/4" clad, and chutes leading to the pulverizers are 1/4" clad.

Stainless-clad steel—a layer of solid stainless steel integrally and permanently bonded over its entire surface to a strong, low-cost carbon steel backing plate—was chosen here for its twofold economy: low initial cost and minimum maintenance. Its smooth surface defies hangups and, with hard use, develops a mirror-like finish. It can extend the service life of coal handling equipment through the useful life of the boiler.

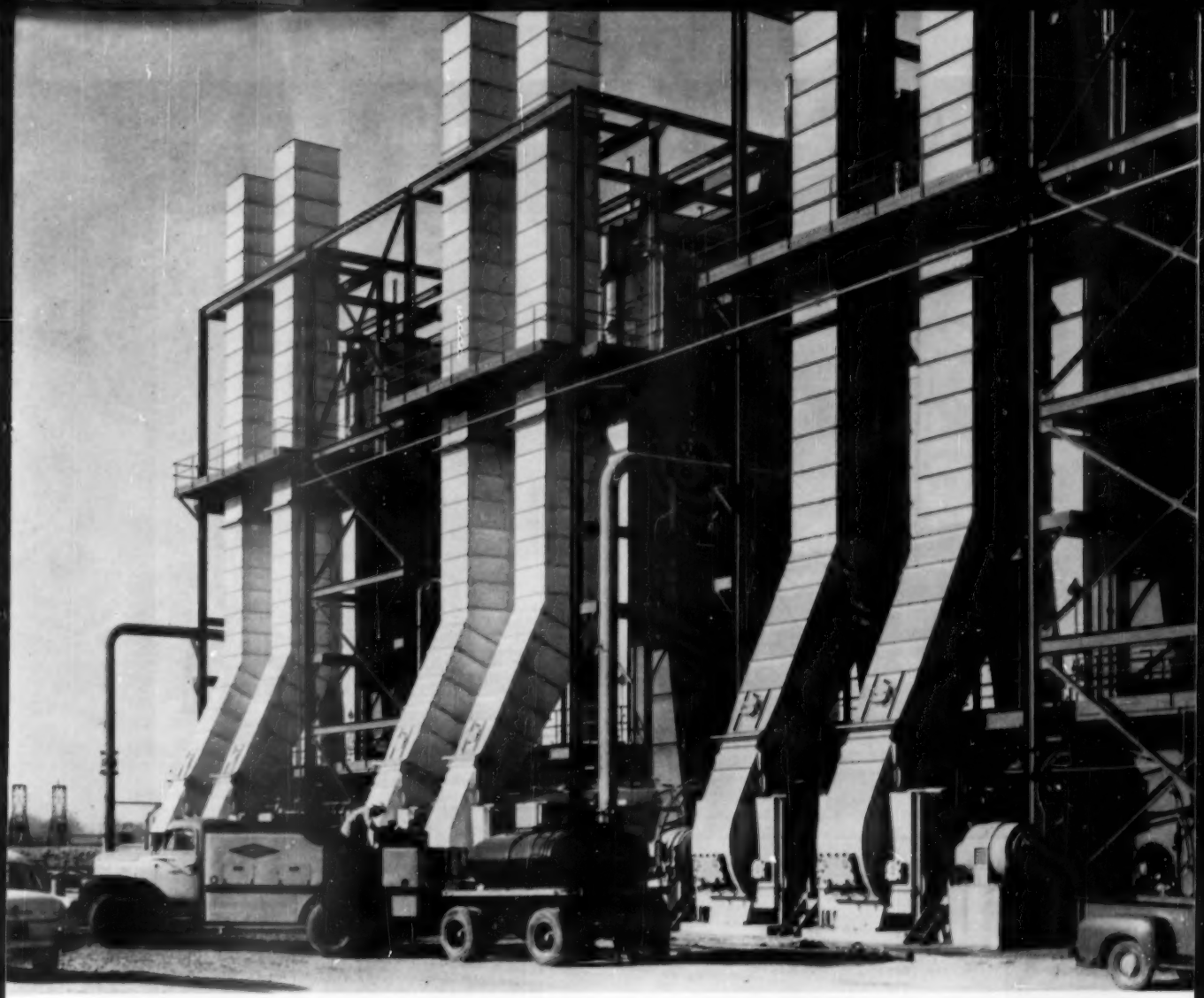
If you would like detailed information, write for Bulletin 740. In addition, our Technical Service Department is available to work with your equipment builders and engineers in putting stainless-clad steel to work for you. If you would like the names of qualified equipment builders, write to the Manager, Marketing Service, 684 Lukens Building, Lukens Steel Company, Coatesville, Pennsylvania.

LUKENS

STAINLESS-CLAD STEELS
FOR INTERIOR COAL HANDLING EQUIPMENT

LUKENS STEEL COMPANY, COATESVILLE, PENNSYLVANIA

PRODUCER OF THE WIDEST RANGE OF TYPES AND SIZES OF CLAD STEELS AVAILABLE ANYWHERE



BOILER TUBE FAILURES ELIMINATED

Regular program of DOWELL chemical cleaning for six boilers ended tube failures due to scale

The tubes of a 500,000 pph boiler in a chemical plant contained an extremely hard high-silicate scale up to 1/16-inch thick. Mechanical cleaning was unsatisfactory, because it required a long shutdown and still left hard scale in the tubes.

Dowell engineers formulated a special solvent and quickly removed the scale from the boiler. The operator now has all six of the 500,000 pph boilers on a regular schedule of Dowell chemical cleaning. Since the beginning of this program, the boilers have been cleaned several times and there have been no tube failures caused by scale deposits.

Chemical cleaning is designed to add years of life to your equipment by helping to protect it from over-heating, galvanic attack, and pitting-type corrosion. Downtime is held to a minimum, because solvents are introduced through regular connections . . . extensive dismantling and scaffolding are not needed.

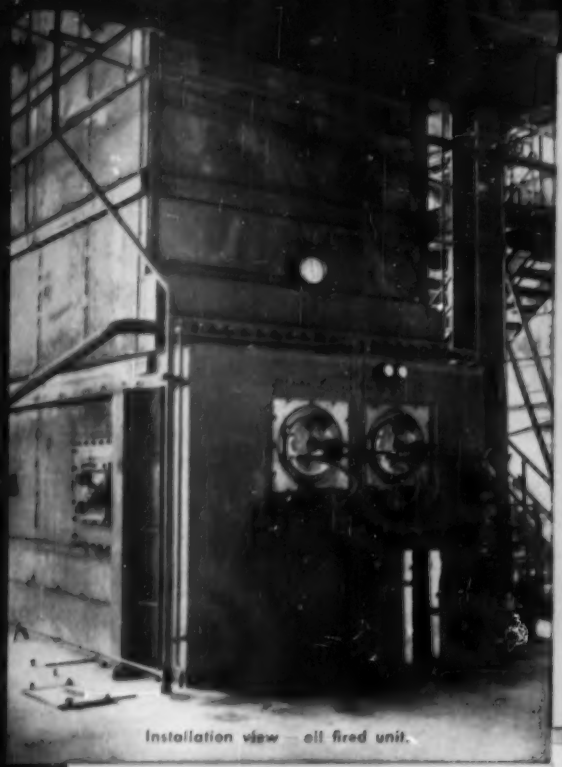
Dowell Service brings you over a decade of experience in the chemical cleaning of many kinds of equipment, including more than 10,000 high- and low-pressure boilers. Contact the nearest Dowell office for more information. Or write Dowell Incorporated, Tulsa 1, Oklahoma, Dept. F-25.

chemical cleaning service for industry

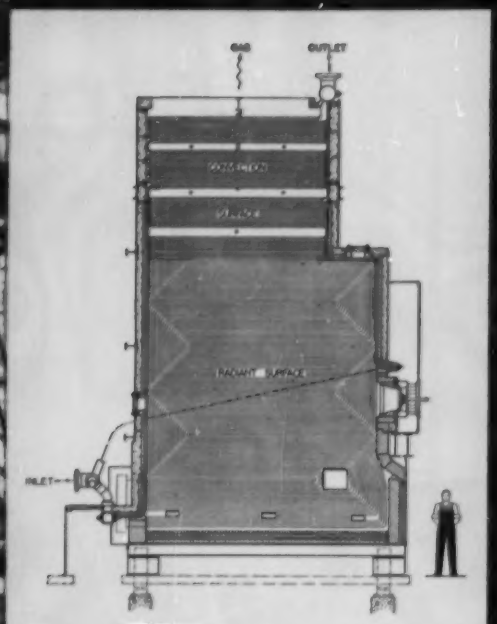
DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

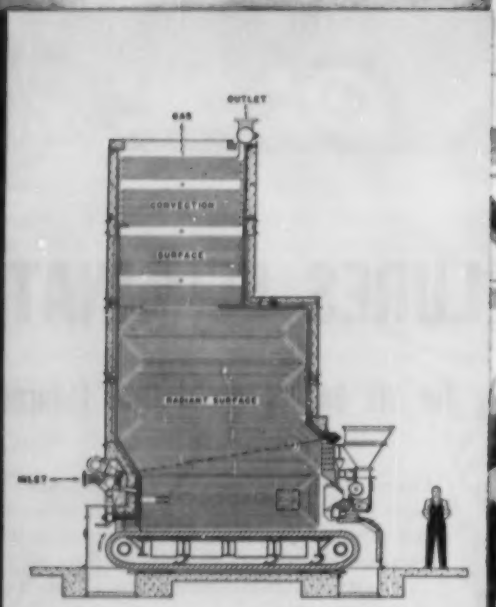
C-E LaMont Controlled Circulation Hot Water Boilers



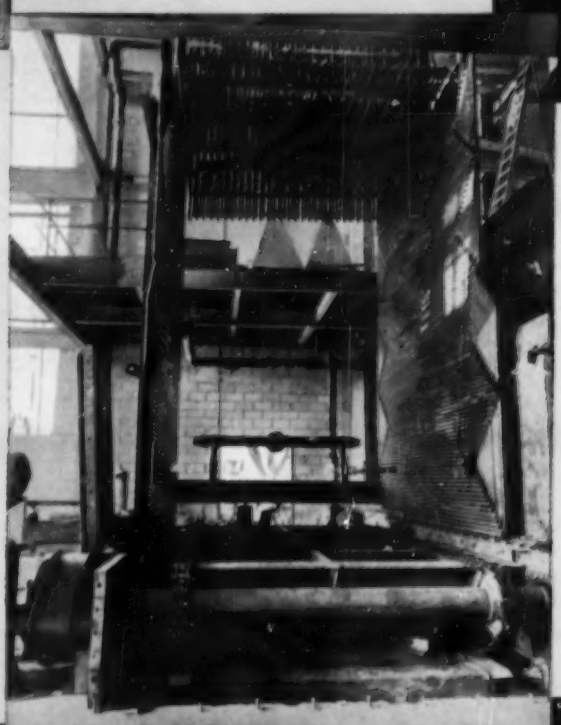
Installation view — oil fired unit.



Typical arrangement — as fired with oil or gas.



Typical arrangement — as fired with C-E Spreader Stoker.



Erection view — with C-E Spreader Stoker.

Ever consider High Temperature Water for your heating and processing needs?

Both steam and high temperature water have their place, and your particular requirements will determine which is best for you. In either case the complete C-E line includes a type and size of boiler exactly suited to your requirements. Where high temperature (HT) water seems indicated, it affords such important advantages as:

1. The higher available heat in HT water . . . many times that of steam at the same pressure.
2. Closer control of temperatures throughout the system.
3. Heat loss is minor with the HT water closed system . . . no condensate losses . . . unused heat returns to the boiler.
4. No elaborate feedwater treatment required because make-up requirements are small.
5. No steam traps are needed, which means elimination of all trap problems and attendant expense.
6. No blowdown losses . . . no safety valve vent losses . . . no condensate return lines.

The planning of any new heating and/or processing system should give proper consideration to the suitability of the HT water system. There are many hundreds of HT water installations operating abroad and a rapidly growing number in the U.S.A. It may be *just right* for *your* requirements.

B-831

Advantages of the C-E Hot Water Boiler

Once it is established that HT water is right for your needs, your next concern is selection of proper equipment. The C-E LaMont Controlled Circulation Hot Water Boiler has inherent advantages that make it the best possible choice. It is especially designed for HT water applications utilizing as it does the principle of forced, controlled circulation which is extended throughout the entire system. This accounts for numerous points of superiority in the C-E LaMont Hot Water Boiler. Among these are:

1. Complete control over HT water movement in both system and boiler.
2. Low pressure loss is inherent so no separate boiler pump is required.
3. Pressurized operation with oil or gas means no induced draft fan — simple stack.
4. Single-pass design — no baffles . . . low draft loss . . . cleaner boiler.
5. More efficient heating surface can be arranged because of positive, controlled circulation.
6. Other features such as: steel enclosed setting — few headers, all accessible — any fuel, oil, gas or coal.

The C-E Hot Water Boiler is available in sizes ranging from 15 to 200-million Btu per hour, or more, with pressures up to 300 psi and temperatures to about 425 F.

If you are in the market for a heating or process system — or expect to be — by all means investigate high temperature water and the C-E LaMont Hot Water Boiler. Our engineers will be pleased to discuss the subject with you or your consultants. Write for our new catalog HT 107.

COMBUSTION ENGINEERING

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

BOILERS, FUEL BURNING & RELATED EQUIPMENT; PULVERIZERS, AIR SEPARATORS & FLASH DRYING SYSTEMS; PRESSURE VESSELS; AUTOMATIC WATER HEATERS; SOIL PIPE

Pace-Setting HD-5G Tractor Shovel

NOW BETTER 3 WAYS

FOR EFFICIENT COAL HANDLING

HD-5G TRACTOR SHOVEL

Rated capacity, standard bucket	1¼ cu yd
Coal handling bucket	2 yd
Belt horsepower	50
Weight, complete	16,200 lb
Dumping height	9 ft, 2 in.

From the time of its introduction seven years ago, the Allis-Chalmers HD-5G Tractor Shovel has been tops in popularity. Many thousands are daily proving their ability and versatility on all kinds of material handling and excavating jobs.

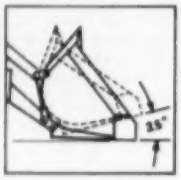
Now, design refinements make the HD-5G a three-way better value than ever before:

1. Has Bigger Rated Capacity

New standard bucket handles a big 1¼-yd load — streamlined design now helps roll in large loads with less tractor effort. The back of the bucket has been brought forward and the sides extended to cut spillage, put more payload where it's wanted. Coal bucket handles 2 yd.

2. Helps the Operator Do More

Cleaner dumping with the new bucket saves the operator time and effort shaking out loads.

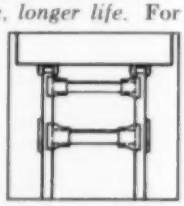


For added versatility, there is a two-position bucket available with both standard automatic return to digging position and operator-controlled tip-back. If the operator chooses to use the controlled tip-back, he can load the bucket, then tip it back approximately 25° before raising, assuring maximum output under special conditions such as downhill loading or loading loose materials.

The HD-5G helps the operator do more in other ways, too — giving him full vision, fast and easy control, cleaner platform and more comfortable seat from which to work, and more working time with truck wheels, support rollers and idlers that need greasing only once every 1,000 hours.

3. Works at Lower Cost

The HD-5G now works at even lower cost than ever before — not just because it *does more*, but because it has features that mean *less maintenance, longer life*. For instance, new type tubular bracing on the bucket booms provides added strength and support, keeps the bucket in line. The floor at the rear of the new bucket has been raised seven degrees to reduce wear on the bottom sheet. Heavy-duty truck wheels and idlers are available for particularly tough working conditions. One-piece, full-length main frame permits unit construction so that major assemblies can be removed without disturbing adjacent units, putting tractor back on the job in hours rather than days.



Ten Quick-Change Attachments Add to HD-5G Versatility

Bulldozer	Crane Hook	Tine Fork
Angledozer	Light Material Bucket	Rock Fork
Narrow Bucket	Trench Hoe	— also rear-mounted Ripper
Rock Bucket	Lift Fork	

See your Allis-Chalmers dealer for more about these and other production-boosting features of the popular HD-5G Tractor Shovel.

ALLIS-CHALMERS
TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

it's **boiler check-up** time!

HOW ARE YOUR BLOW-OFF VALVES?

Are they drop-tight? Rugged and dependable? Easy to maintain?

Just as important, do they have all the advantages and up-to-date improvements in materials and design of new YARWAY Blow-Off Valves?

Old YARWAY Blow-Off Valves also can be overhauled and modernized, because all YARWAY improvements are *interchangeable* with parts on earlier models.

Write today for free YARWAY Blow-Off Valve CHECK SHEET—also new YARWAY Blow-Off Valve Catalog B-426 (pressures to 400 psi) or B-434 (pressures to 2500 psi).

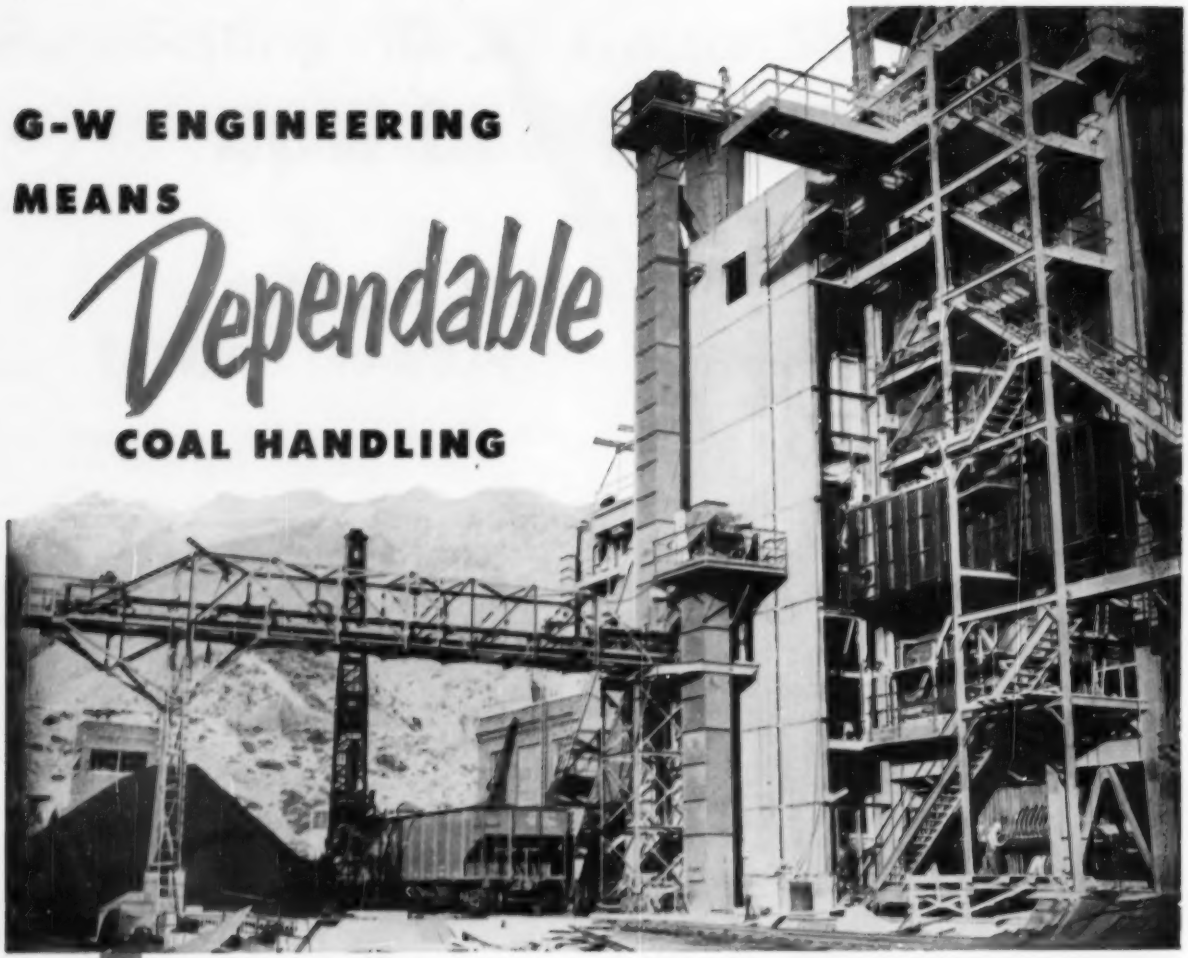
YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

Yarway Seatless valve for low and medium pressures. Features balanced nitralloy plunger that seals line drop tight—yet permits free, unobstructed flow in blow-down. **Used in over 15,000 boiler plants.**

Yarway Unit Tandem Blow-Off Valve for higher pressures. Combines Yarway Seatless Valve and Yarway Hard-Seat Valve, or two Yarway Hard-Seat Valves in a one-piece forged steel body. For years—the choice of 4 out of 5 high pressure power plants.

YARWAY blow-off valves

G-W ENGINEERING MEANS *Dependable* COAL HANDLING



The Gifford-Wood coal handling system at the Orem steam electric station of Utah Power & Light Company is designed to handle run-of-mine bituminous coal at 100 tons per hour from dual track hoppers to ground storage, or to overhead storage bins for automatic delivery to boilers. Coal handling is automatic . . . economical . . . completely dependable. The installation, protected by electrical interlocks, is a perfect example of the rugged design and flexibility that can be built into the operation of a well designed power plant.

This complete coal preparation and handling system is but one of the many solutions to dependable low cost coal handling . . . Solutions designed by G-W engineers . . . based upon over 135 years of experience accumulated by G-W in the methods of design, engineering and installation of all types of materials handling systems. Bulletin No. 300 contains the complete story. Send for your copy now, it may well lead to lowered costs tomorrow.

GIFFORD-WOOD CO.

Since 1814
HUDSON, NEW YORK

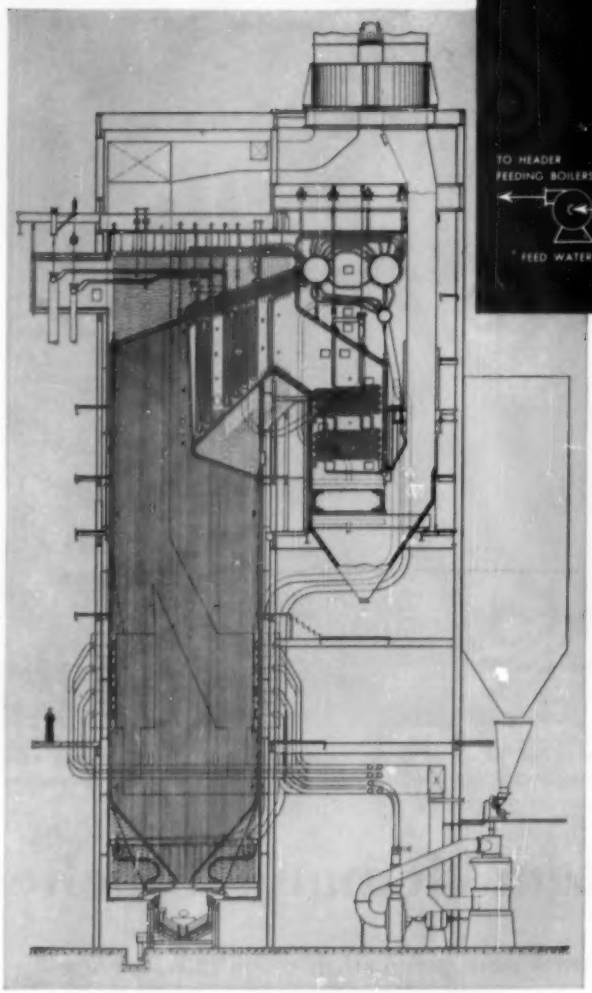
NEW YORK 17, N. Y.
420 Lexington Ave.

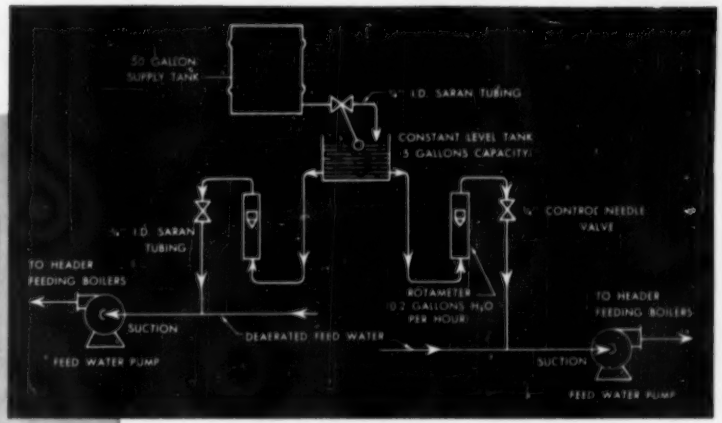
ST. LOUIS 1, MO.
Railway Exchange Bldg.

CHICAGO 6, ILL.
565 W. Washington St.

7635

When You Think of Materials Handling . . . Think of Gifford-Wood





In both high-pressure and low-pressure steam plants, the following practical applications of hydrazine are now well established: (1) removal of trace oxygen from feed water, (2) preservation of superheater tubes in steam generating plants before they go into operation, (3) protection of idle boilers. Published reports of experience in this country as well as abroad, in power stations and industrial steam plants, indicate the efficiency of hydrazine treatment.

Hydrazine is a strong reducing agent which reacts rapidly with residual oxygen, eliminating all traces of this dissolved corrosive gas. Most important, the complete oxidation of hydrazine by dissolved oxygen results in water and nitrogen, imparting no additional "total solids" to the feed water. Moreover, hydrazine hydrate is an alkaline solution—a 1% solution of $N_2H_4 \cdot H_2O$ has a pH value of 9.9 at 25°C.

To get the latest information on the deoxygenation of steam systems with hydrazine, see your Mathieson representative or write today.

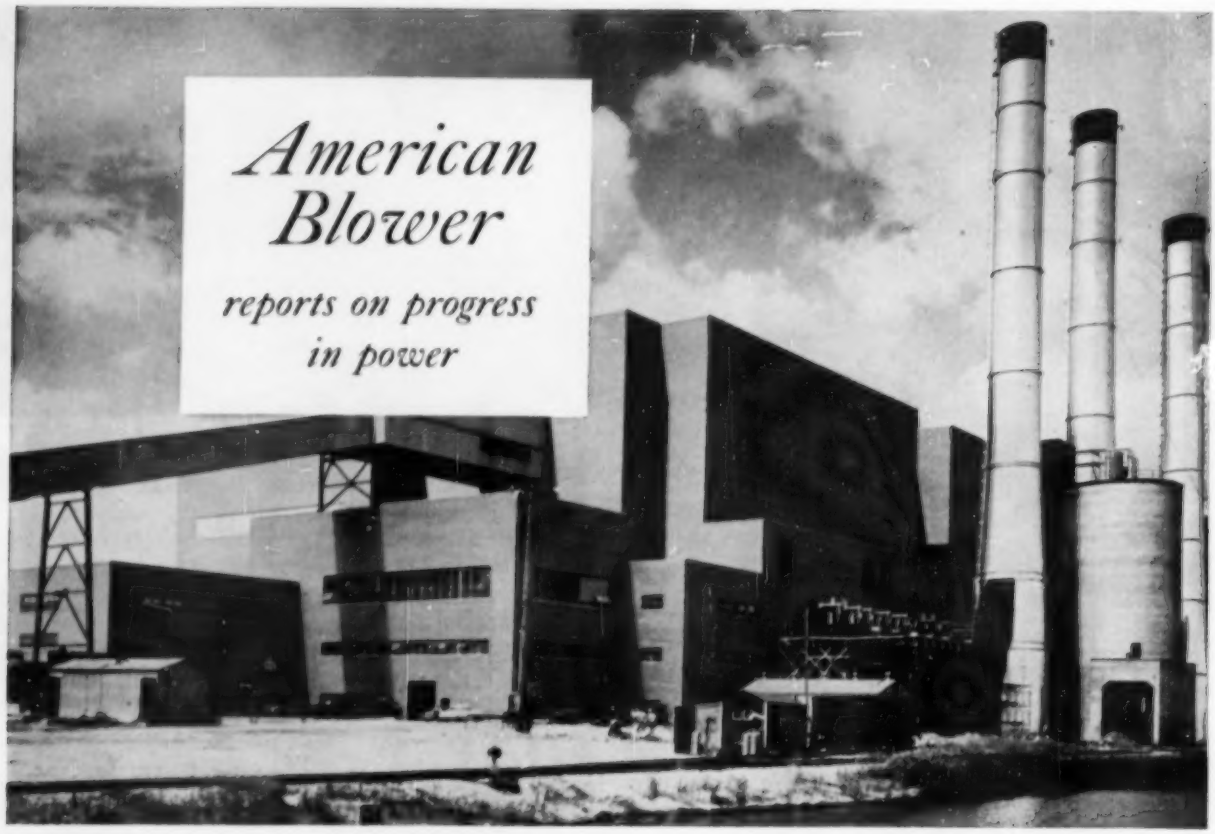
control oxygen corrosion... protect boiler systems with

HYDRAZINE HYDRATE

MATHIESON

MATHIESON CHEMICALS
OLIN MATHIESON CHEMICAL CORPORATION
INDUSTRIAL CHEMICALS DIVISION · BALTIMORE 3, MD.

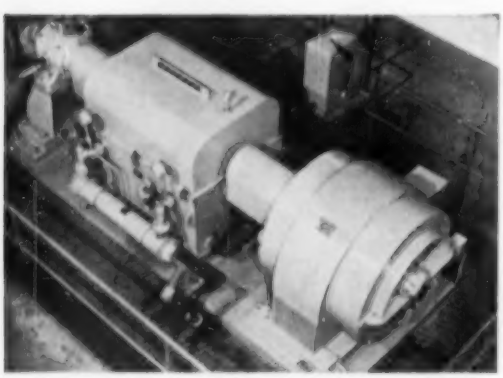
3080



St. Clair Power Plant is one of five stations in The Detroit Edison Company system. It was dedicated October 21, 1954, 75 years after Thomas A. Edison perfected the first practical light bulb. A sixth power station is under construction.

Detroit Edison system demand reaches

The Detroit Edison Company puts new generating units into service at St. Clair plant to meet Southeastern Michigan needs; relies on American Blower Gýrol Fluid Drives for boiler feed pump and fan control.

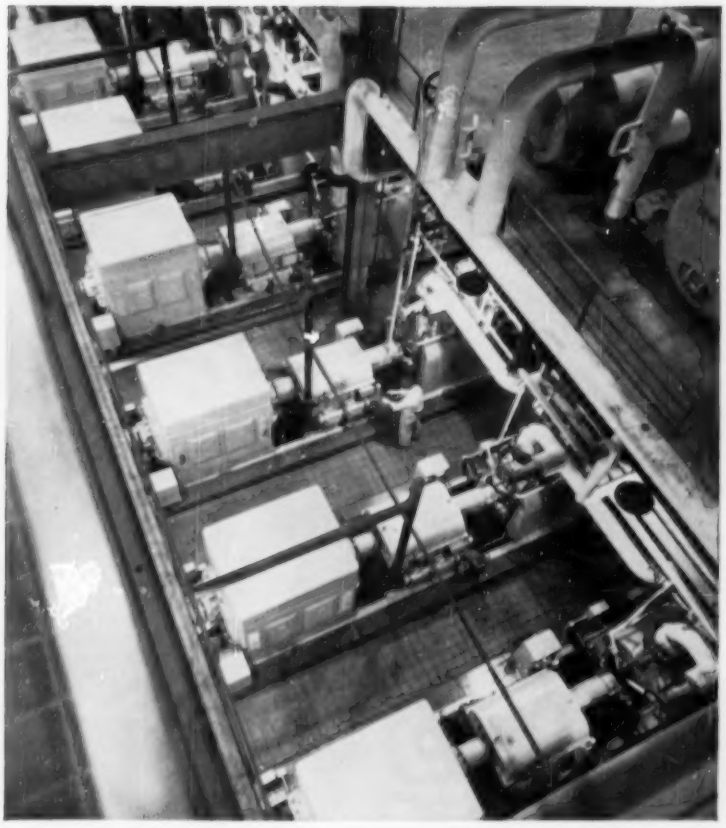


American Blower, Type VS, Class 4, Gýrol Fluid Drive unit drives induced draft fan on one of four boilers in Edison's St. Clair plant. 16 units deliver 15,600 h.p. to the mechanical draft fans.

By year's end, 1954, The Detroit Edison Company electric power system had developed a total capability of 2,535,000 kilowatts. Two new turbine-generators at Edison's St. Clair Power Plant went into operation, boosting the system's capability 312,500 kilowatts.

The boost was timely. A large increase in domestic customers, and very substantial additions of new industrial loads in Southeastern Michigan, had placed new power demands on the Edison system – 214,000 kilowatts more than the peak load for 1953.

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS •



American Blower Gyrol Fluid Drives provide adjustable speed control for the boiler feed pumps at St. Clair station. Shown are six of twelve. Total capacity: 20,400 h.p.

all-time peak of 2,236,000 kilowatts

From concrete to kilowatts

The new St. Clair Power Plant serves Michigan's southeast area, with a total guaranteed capacity of 625,000 kilowatts. Construction of the plant began in February, 1951, and it now houses four giant turbine-generators, each with a 156,250 kilowatt capability. The first and second machines began operating in the fall of 1953; the third in June, 1954, and the fourth in October of that year.

Four boilers produce steam for the turbine-generators. Each unit has three combination boiler feed and heater feed pumps. American Blower Gyrol Fluid Drives are used to ensure smooth, adjustable speed control of the boiler feed pumps.

In its post-war expansion program, The Detroit Edison Company has incorporated American Blower Gyrol Fluid Drives to the extent of nearly 100,000 h.p. At the St. Clair Power Plant, these fluid drives deliver a total of 36,000 h.p. in driving the feed pumps and mechanical draft fans.

Call on American Blower

If you are planning to expand or modernize your facilities, contact your nearest American Blower representative. He can recommend efficient, economical equipment – including Mechanical Draft Fans, Fly Ash Precipitators, Dust Collectors, Heavy Duty Steam Coils, as well as Gyrol Fluid Drives for boiler feed pump and fan control. Call your nearest American Blower Branch Office for full information.

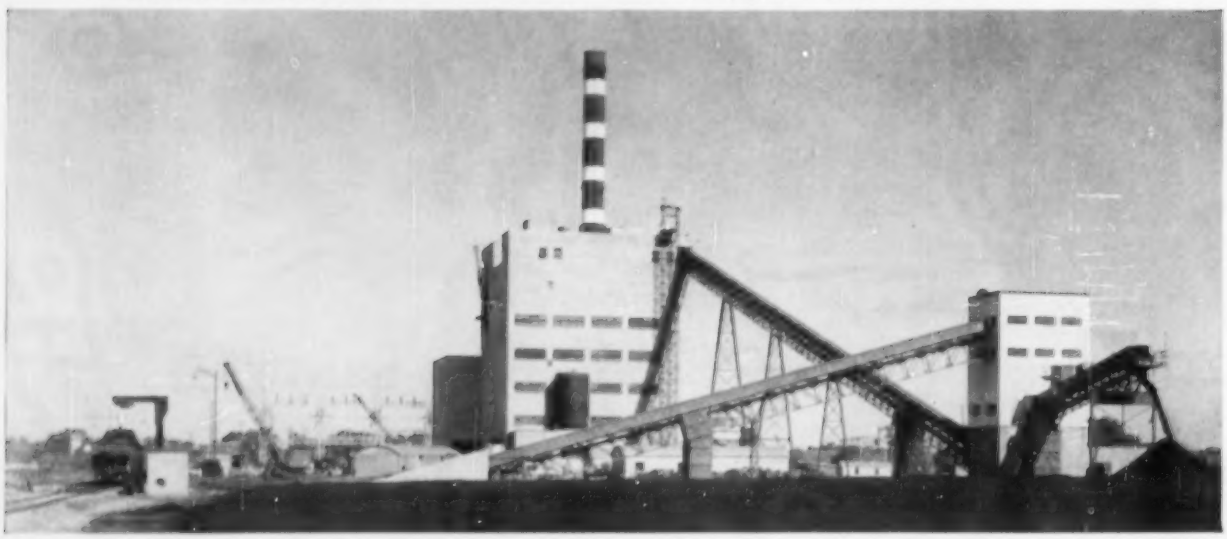
AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER

KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS

Above: the Blackhawk Station—Wisconsin Power and Light Company. Present capacity 50,000 kw.

Below: the Rock River Station—Wisconsin Power and Light Company. Present capacity 60,000 kw.



Teamwork Tells the Story

Blackhawk and Rock River generating stations are part of the large Wisconsin Power and Light Company power plant system. They inject 110,000 kw. of electrical power into the veins of midwest industry. Officials and the engineering staff planning with Sargent and Lundy, their consulting engineers, wisely provided for the future of both plants as power needs increase. Significantly, dependable Rex® Conveyors perform the important coal-handling job.

Any time you combine the top-flight construction of Sargent and Lundy with the experience and know-how of Chain Belt Conveying Engineers, the result is sure to be low-cost, efficient coal handling for years to come.

When you plan a new coal-handling system or consider additions to your present facilities, put the specialized skill of Chain Belt Engineers to work for you.

Call in your nearest Chain Belt Company Representative. He will give you complete information on how to get the most for every coal-handling dollar you invest. Or, if you prefer, write direct to Chain Belt Company, 4734 West Greenfield Ave., Milwaukee 1, Wisconsin.

CHAIN BELT COMPANY

District Sales Offices in all Principal Cities

YOU USE BRICK TO BUILD A BUS

Behind everything that's made or moved lies the refractory brick that contains the flames, the enormous heats, of industry.

Without refractory brick, you'd see no bus in this picture. Nor any picture, for that matter.

Making refractories for the infinite requirements demanded of them is a precise and exacting science, stemming from vast resources of mines, minerals and laboratory control.

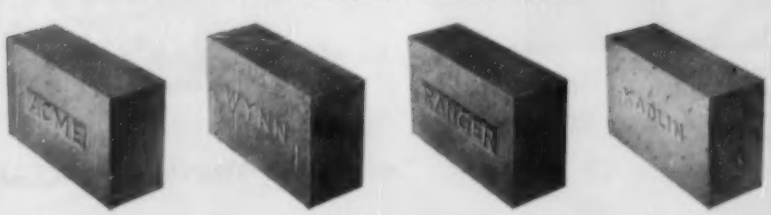
And General Refractories provides them from multiple plants and warehouses strategically located to serve industry swiftly . . . dependably . . . economically.

GENERAL REFRACTORIES CO.
Philadelphia 2

GENERAL REFRACTORIES

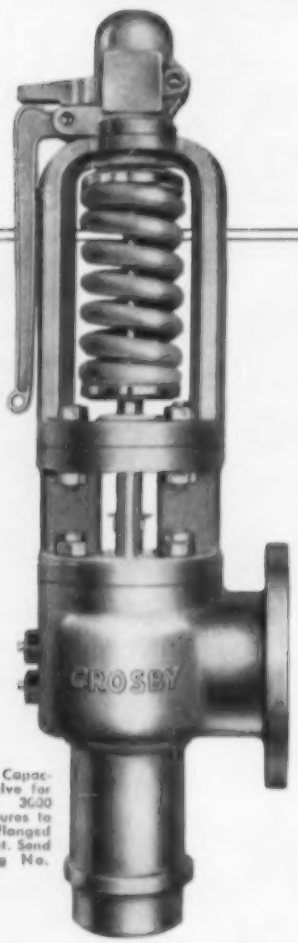
COMPLETE REFRACTORIES SERVICE

FOR STEAM GENERATION . . . First quality fireclay brick plants strategically located across the U.S.



"There is hardly anything in the world that someone cannot make a little worse and sell a little cheaper—and the people who consider price alone are this man's lawful prey."*

John Ruskin



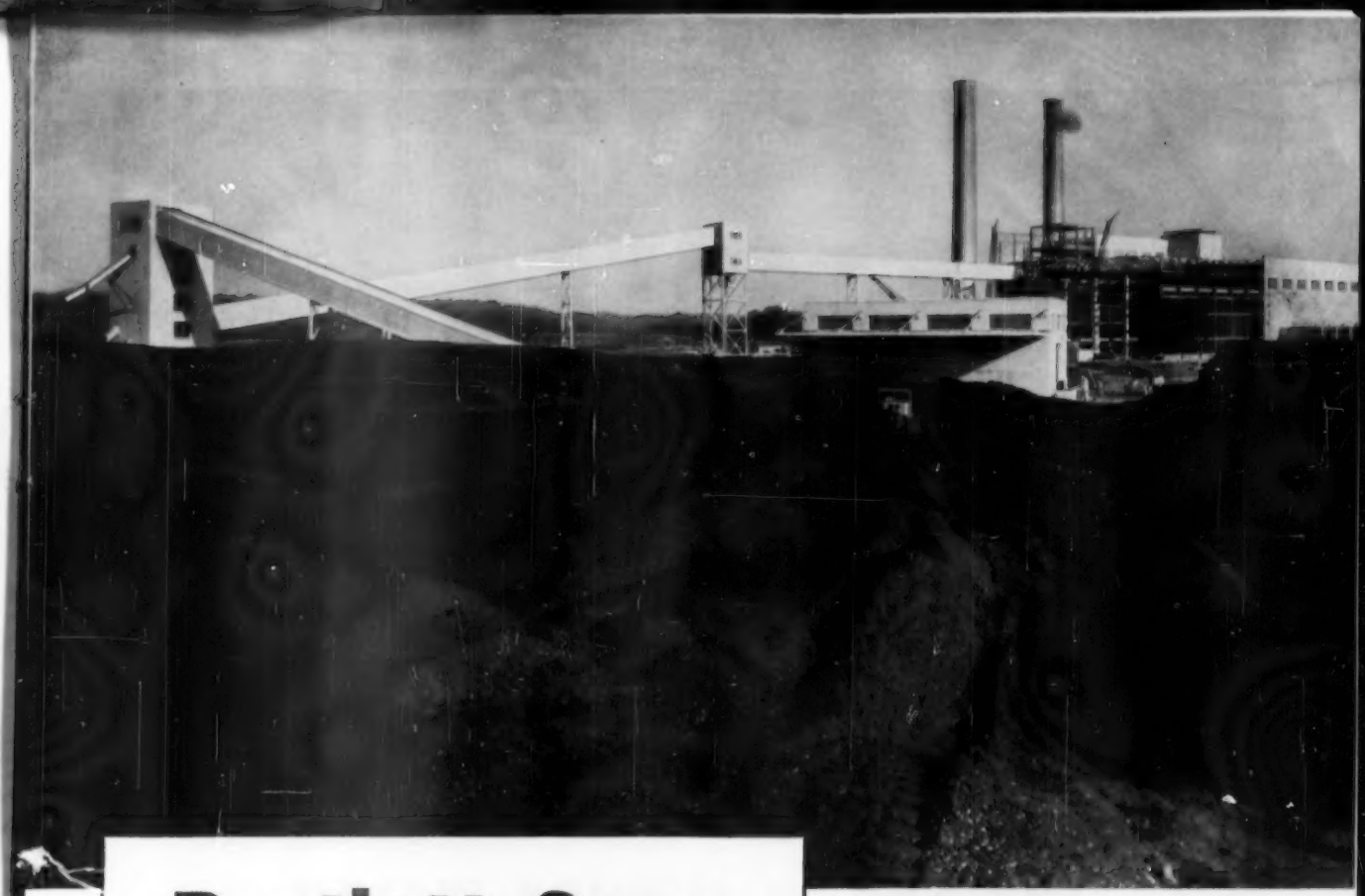
Crosby High Capacity Safety Valve for pressures to 3600 lbs., temperatures to 1050 F. with flanged or welded inlet. Send for Catalog No. 400-HC.

* We make our products better but never cheaper . . . striving for quality and performance, rather than the lowest price.

Crosby Steam Gage and Valve Company, 43 Kendrick Street, Wrentham, Mass. . . . manufacturers of Safety Valves, Relief Valves, and Pressure Gages.

Crosby

KEEPS PRESSURE ON THE SAFE SIDE



General View of O. H. Hutchings Station
Dayton Power and Light Company
Ebasco Services Incorporated
Consulting Engineers

Bartlett-Snow coal handling at Dayton

● The view above shows the first 120,000 KW unit of a plant which will be extended into a 360,000 KW station. The track and reclaiming hoppers, apron feeders, the three 700 ton per hour belt conveyors that total 1,178 feet in length, gates, chutes, and transfer points were detailed and fabricated in our shops and installed by our erectors to Ebasco Services Incorporated's specifications. For maximum efficiency and fixed unit responsibility, let the Bartlett-Snow coal handling engineers work with you on your next job.

Gates and Apron Feeders Under
Track and Reclaiming Hoppers

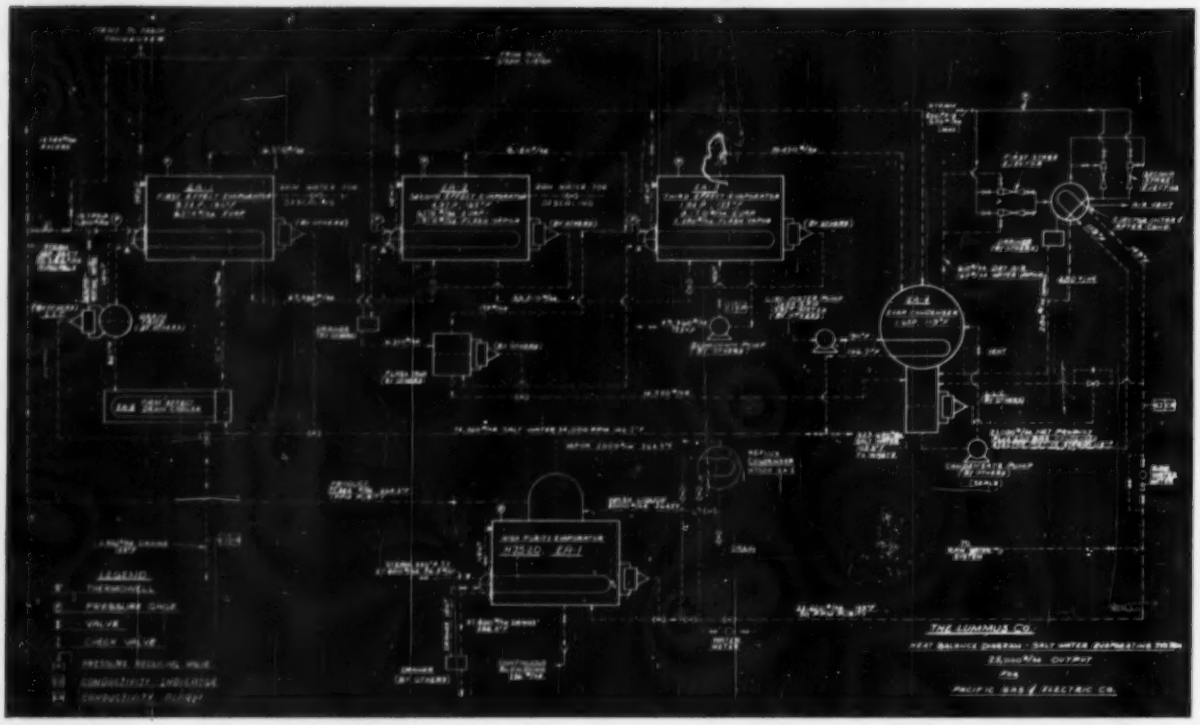
Drive For 700 Ton Per Hour
Belt Conveyor

DESIGNERS ENGINEERS

BARTLETT-SNOW
CLEVELAND 5, OHIO

FABRICATORS ERECTORS

"Builders of Equipment for People You Know"



THIS EVAPORATOR SYSTEM CONVERTS THE SEA INTO PURE WATER

The Lummus Company, working closely with Pacific Gas & Electric Co. and Bechtel Corporation, has designed and built a system consisting of triple effect evaporators and high purity bubble tray evaporators, one set for each of two boilers.

Each evaporator system will produce 50 gallons per minute of fresh water at design conditions having a vapor purity of less than 1 ppm total dissolved solids, from sea water containing approximately 36,000 ppm dissolved solids.

The ocean water first enters the evaporator condenser and then goes to the first effect drain cooler where it is heated to 150°F. before entering the first effect evaporator shell. From the first effect evaporator shell, the ocean water cascades to the second and third effect evaporator shells at which point its concentration would be one and one-half times that of the entering ocean water.

The vapor from the first and second effect shells is used as the heating medium for the second and third effect shells. Steam from the fourth bleed point of the turbine is used as the heating medium for the high purity evaporator, and part of the vapor from the high purity evaporator is used as the heating medium for the first effect evaporator. The excess vapor produced in the high purity evaporator is bled to the main condenser.

Lummus engineers will be pleased to work with you on your next project.

THE LUMMUS COMPANY, Heat Exchanger Division: 385 Madison Avenue, New York 17, N. Y. Atlanta • Boston • Chicago • Cincinnati • Cleveland Dallas • Denver • Detroit • East Chicago, (Indiana) Houston • Kalamazoo • Kansas City • Los Angeles Minneapolis • Nashville • Newton (Iowa) • Niskayuna (New York) • Omaha • Pittsburgh • Rochester • Salt Lake City • San Francisco • Springfield (Massachusetts) Toledo • Wayne (Penn.) • Athens • Buenos Aires Caracas • The Hague • Lima • London • Mexico City Montreal • Paris • Rome • San Juan

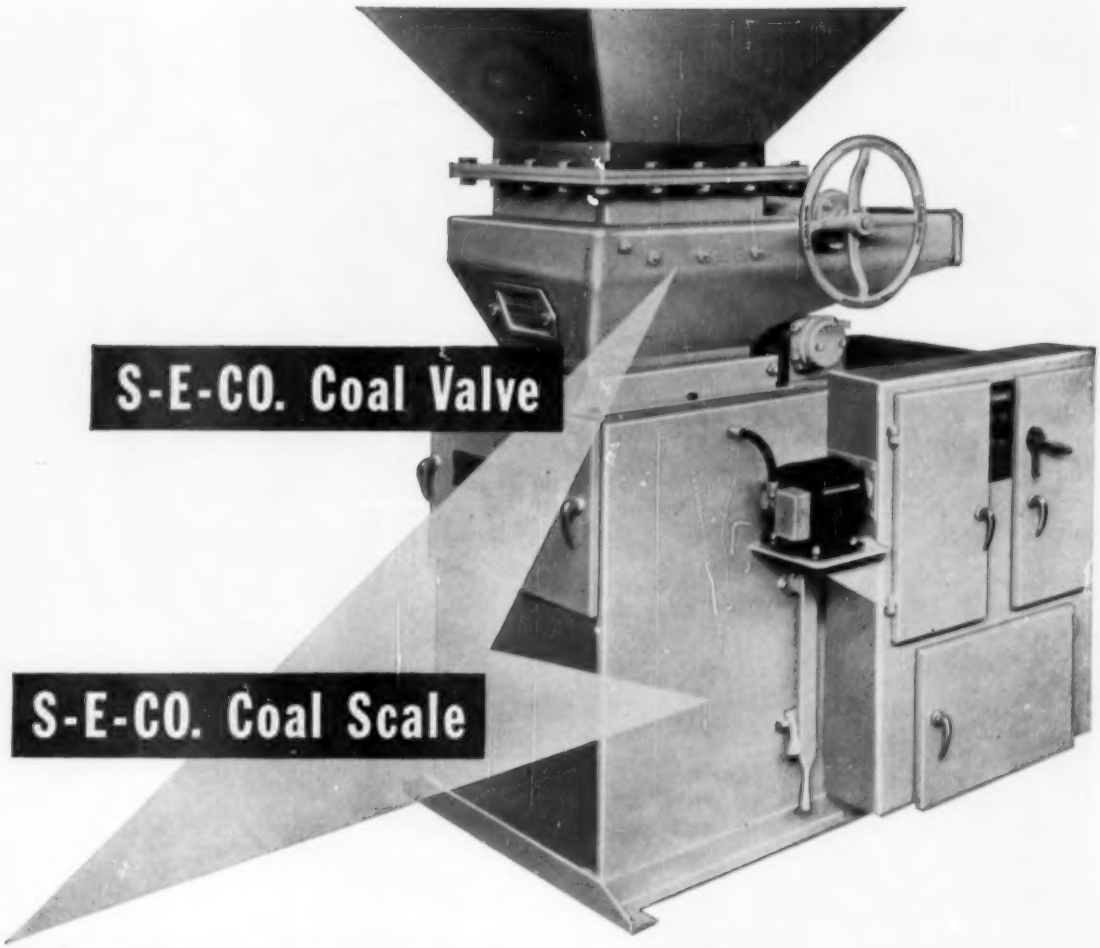
Fabricated Piping Division Plant at East Chicago, Ind.

Steam Surface Condensers • Evaporators • Extraction Bleeder Heaters • Steam Jet Air Ejectors • Steam Jet Refrigeration • Barometric Condensers • Heat Exchangers for Process and Industrial Use • Process Condensers • Pipe Line Coolers.

LUMMUS
HEAT EXCHANGER DIVISION

LUMMUS

THE LUMMUS COMPANY HEAT EXCHANGER DIVISION, 385 MADISON AVE., NEW YORK 17, N. Y.



DESIGNED for each other and for Your Plant

. . . that's why you get more value when you buy S-E-Co.

Notice how the valve and scale fit together. The valve outlet forms part of dust-tight slip joint at scale inlet. The scale is designed to allow the valve dust cover to extend over it, not into the aisle where it is an accident hazard . . . and the whole arrangement is not only compact but built to last — and last.

In addition to coal scales and valves, the carefully designed and manufactured S-E-Co. line of products includes the CONICAL Non-Segregating Distributor; Automatic Underbunker Conveyor; Turn Counting and Paddle Type Coal Stoppage Alarms; and all other items required to make a complete, dust-tight and dependable Bunker to Pulverizer or Stoker installation.

For complete information on any S-E-Co. product write:

SPECIALISTS IN
BUNKER TO PULVERIZER AND
BUNKER TO STOKER EQUIPMENT

STOCK Equipment Company

745-C HANNA BLDG., CLEVELAND 15, OHIO

a practical answer to

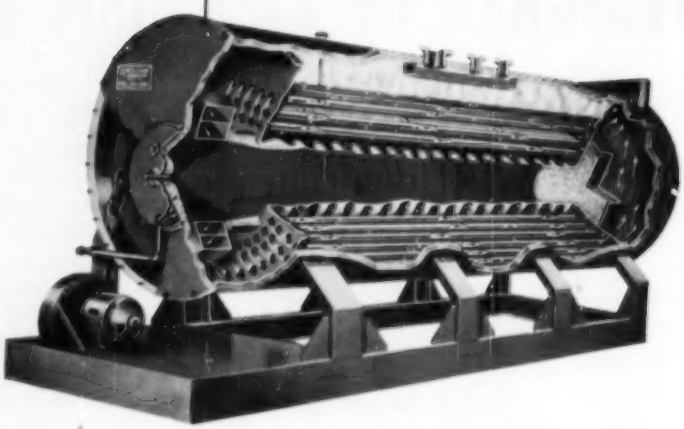
CARBOFRAX liner is made of 1¾"-thick segments of tile.

in steam generators

Here's how one manufacturer of package steam generators builds extra life into his units. He uses a 1¾"-thick lining of CARBOFRAX® silicon carbide tile to shield the metal surfaces at the mouth of the firing tunnel from the severe heat shock and corrosive action of the hot fuel gases as they blast from the burner tube.

Since CARBOFRAX refractories conduct heat nearly as rapidly as alloy steel (11 to 12 times as fast as fireclay), there's little or no interference with heat transfer in the area of the liner. As a matter of fact, the hot face of the CARBOFRAX tile actually helps get maximum fuel efficiency by improving combustion.

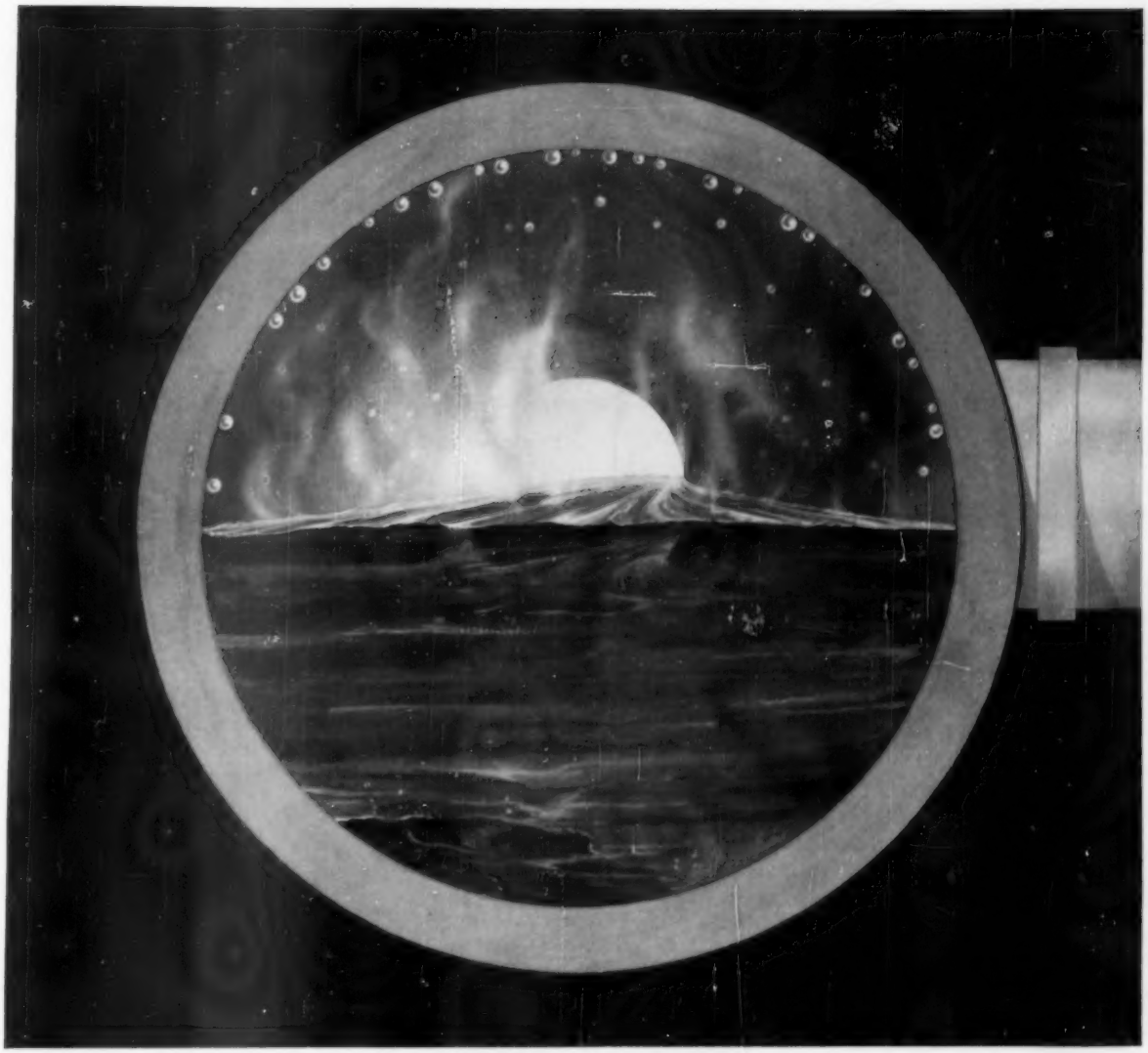
Ames Iron Works is one of many progressive builders of steam generating equipment who have recognized the wisdom of applying Super Refractories by CARBORUNDUM where combustion conditions are most severe. Wouldn't it pay you to consider these materials the next time one of *your* hot spots needs attention? Write today for our 32-page summary of Super Refractory applications in boiler trouble spots. Address Department E65, The Carborundum Company, Perth Amboy, New Jersey.



"Amesteam" generator is built by Ames Iron Works, Inc., Oswego, N. Y. The CARBOFRAX liner is used in all Ames generators rated 200 HP, or above, that burn heavy fuel oil.

CARBORUNDUM

Registered Trade Mark



WHAT'S A MONOMOLECULAR FILM?

It is a film one molecule thick. Filmeen* in steam or condensate lines produces a monomolecular film.

But, there's a lot more to it than thickness. The film's most important function is protection against corrosion. By forming a nonwettable coating on all metal surfaces with which treated steam or condensate come in contact. Filmeen provides a protective, corrosion-inhibiting barrier between water and metal. In heat exchange equipment, the condensed steam treated with Filmeen then forms as spherical drops of water which resist adherence to the film surface, much the same as a drop of water will form into a small ball on a waxed surface. This phenomenon results in increased rate of heat transfer—which in turn saves money in power plant operation.

When steam condenses on untreated return lines, it forms a continuous layer of water that restricts heat transfer. You don't want that... it raises the cost of heat.

Your Dearborn sales engineer will gladly explain how Filmeen can keep your heating costs in line.

**Filmeen is the trade-mark of a corrosion-inhibiting compound produced exclusively by Dearborn Chemical Co. U.S. Pat. No. RE 23614.*

Dearborn®

a leader in water conditioning and corrosion control

Dearborn Chemical Company
Dept. COM, Merchandise Mart Plaza, Chicago 54, Ill.

Please send me complete information about Filmeen.

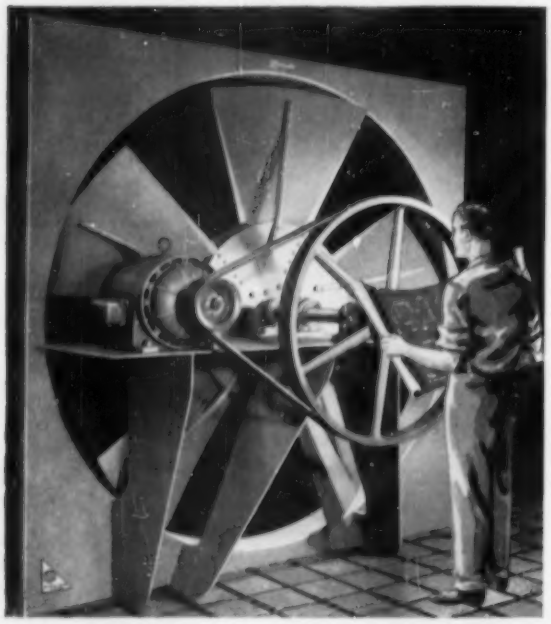
Name.....*Title*.....

Company.....

Address.....

City.....*Zone*.....*State*.....

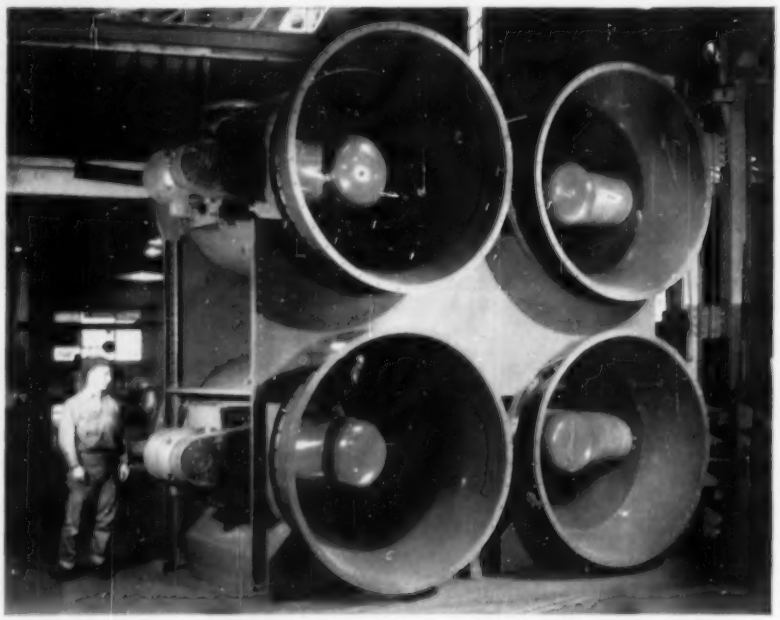
YOU DON'T NEED TO BROIL IN THE BOILER ROOM!



"BUFFALO" PACKAGE PROPELLER FANS are giving excellent results in removing excess heat from boiler rooms of large utility stations and industrial power plants — efficiently "moving out" large volumes of hot air to make boiler rooms cool, pleasant places to work in. The large 96" Package Propeller Fan shown is typical of the unusual efficiencies in this popular "Buffalo" line. Moving 80,000 cfm at ¼" static, it requires only a 15 H.P. motor. These fans operate against as high as 1" pressure, and sizes range up to 144" (this 12-foot wheel delivering 250,000 cfm!). For the economical answer to boiler room cooling, write today for BULLETIN FM-1234.

"BUFFALO" AXIAL FLOW FANS, too, are becoming increasingly popular with power plant operators because of their extremely high efficiency, light weight and suitability for duct mounting. If practical, heated air from the boiler room may be distributed to other areas by duct. These fans have the "Limit-Load" horsepower characteristic — they cannot be overloaded. At right is a 4-fan "package" unit now effectively cooling a prominent power plant. WRITE FOR BULLETIN 3533-C. In all "Buffalo" Fans, you get a built-in value known as the "Q" Factor* — the product of 78 years of air handling experience.

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*



"BUFFALO" ALSO BUILDS the Induced Draft, Forced Draft, Primary Air, Gas Recirculating and other Fans that are helping to produce economical power for many of the country's best-known installations. WRITE FOR BULLETIN 3750.

"Buffalo"

BUFFALO FORGE COMPANY

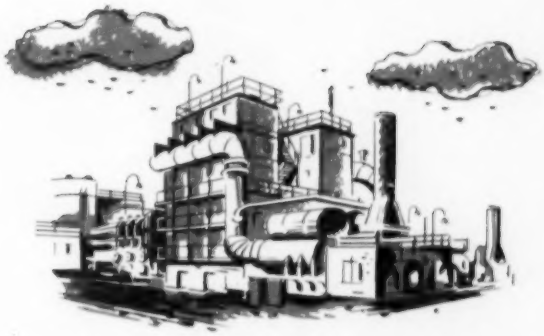
170 MORTIMER ST. BUFFALO, N. Y.

PUBLISHERS OF "FAN ENGINEERING" HANDBOOK

Canadian Blower & Forge Co., Ltd., Kitchener, Ontario

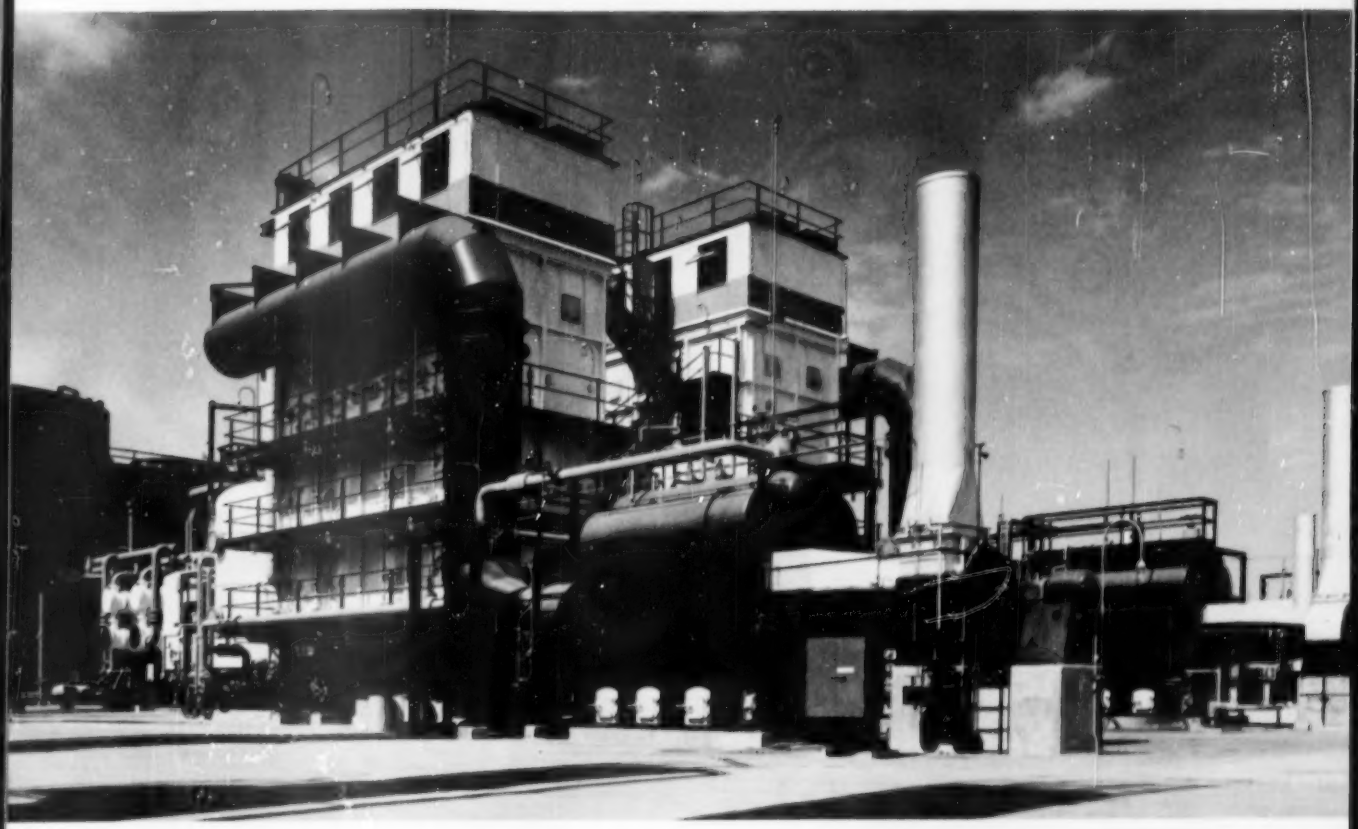
Sales Representatives in all Principal Cities

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING



Water treatment by NALCO

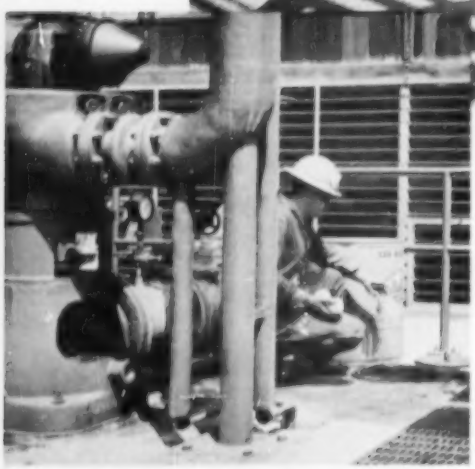
protects boilers and cooling system of a big new ammonia plant



Processing units (left) and Nalco-protected waste heat boilers in new $13 million Brea Chemicals, Inc. ammonia plant.

When $13,000,000 goes into a brand new ammonia plant . . . equipment, services and supplies must be right up to snuff from the start. The Nalco System has been working here from the beginning—and the Nalco treatments and services rendered in a successful plant-wide program point up the advantages to be gained with the Nalco System in plants new or old.

See the next page for details on Nalco results on Ammonia Road.

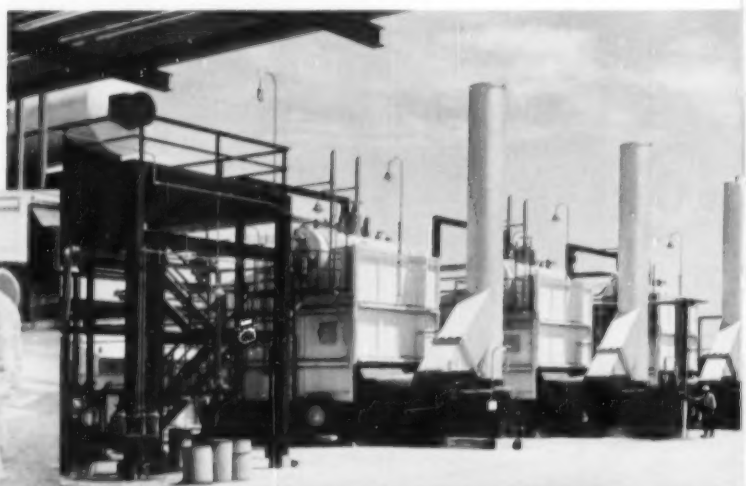


Nalco System treatments on Ammonia Road solve these important water and steam processing problems: scale and corrosion prevention in both water and steam systems; boiler-water foam control and sludge-conditioning; and contamination-free process steam.

Whatever your water treatment problems may be—in a plant of any size—there is a Nalco System program designed to solve them, permanently . . . and economically. Write or phone today for details.

Top—Large cooling tower at this new west coast ammonia plant gets protection against scaling and corrosion with a non-toxic Nalco formula. Low pH treatment stops deterioration of cooling tower lumber and cuts dosage requirements for slime and algae control.

Above—Ball form cooling water treatment is merely dropped into a simple wire basket device suspended in cooling tower basin.

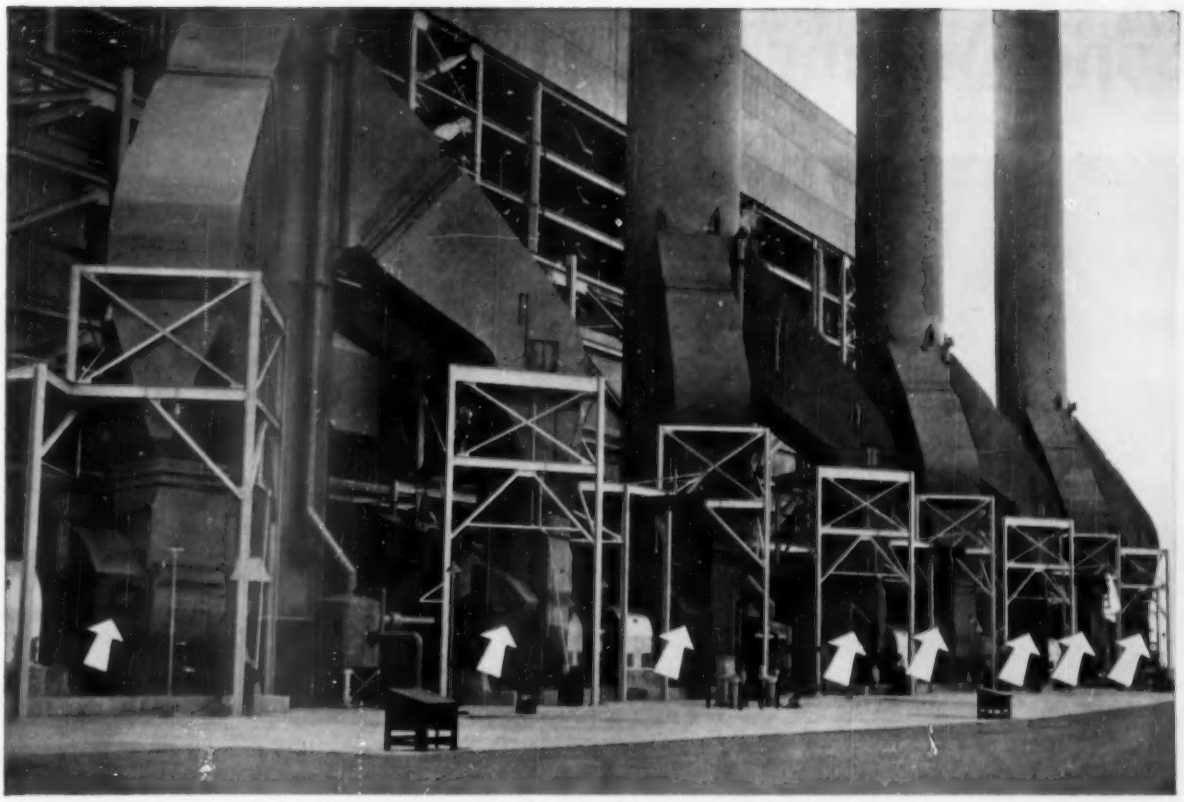


Above—Three steam generators on outdoor settings provide superpure steam for ammonia processing and heating. Nalco chemicals in ball-briquet form are put into by-pass feeders *(left)* to insure trouble-free water treatment on Ammonia Road.

NATIONAL ALUMINATE CORPORATION
Phone: POrtsmouth 7-7240
6216 West 66th Place
Chicago 38, Illinois

In Canada, Alchem Limited
Burlington, Ontario

THE nalco® SYSTEM . . . Serving Industry through Practical Applied Science



Pacific Gas & Electric Company's Pittsburg (California) Station

New Pacific Gas & Electric's Pittsburg Station . . . 660,000 KW . . . Uses 16 Westinghouse Mechanical Draft Fans

Largest Steam Plant in West Uses Westinghouse Fans for Induced and Forced Draft

Here, eight Forced Draft and eight Induced Draft Westinghouse Fans and Motors serve four boilers, each producing 1,135,000 pounds of steam per hour at 1850 psig and 1,000° F.

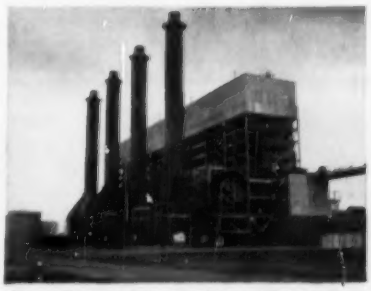
Two Forced Draft Fans driven by 900 hp motors provide 219,000 cfm each at 20.1" static pressure.

Two Induced Draft Fans driven by 920/1250 hp motors move 358,000 cfm at 375° F., 10.7" static pressure to each boiler with provision for coal firing.

These mechanical Draft Fans are specifically designed for outdoor installation.

For power generation—or for any other air handling job, let Westinghouse-Sturtevant put air to work for you—economically, efficiently.

FOR MORE FACTS on the industry's most complete air handling line, call on the "Man with the Facts", your Westinghouse-Sturtevant Sales Engineer, or fill in the handy coupon below.



Over-all view of Pacific Gas & Electric Company's Pittsburg Station showing four huge boilers and 16 Westinghouse Forced Draft and Induced Draft Fans.

WESTINGHOUSE AIR HANDLING

YOU CAN BE SURE... IF IT'S

Westinghouse

J-80444

Westinghouse Electric Corporation
Sturtevant Division, Dept. 10E
Hyde Park, Boston 36, Mass.

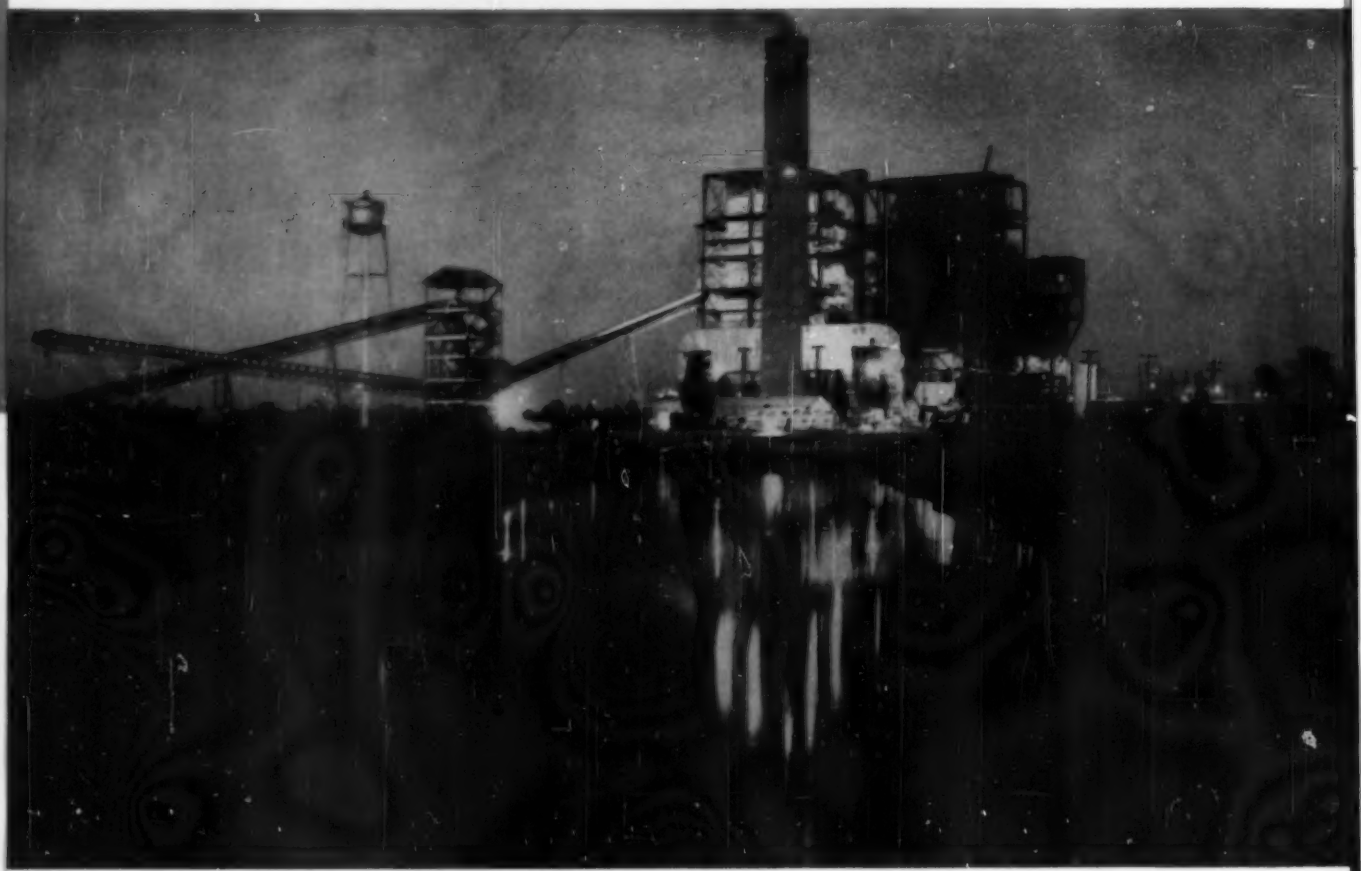
Please send facts on Westinghouse Mechanical Draft equipment.

NAME AND TITLE.....

COMPANY.....

CITY.....STATE.....

Copes-Vulcan helps to make MORE

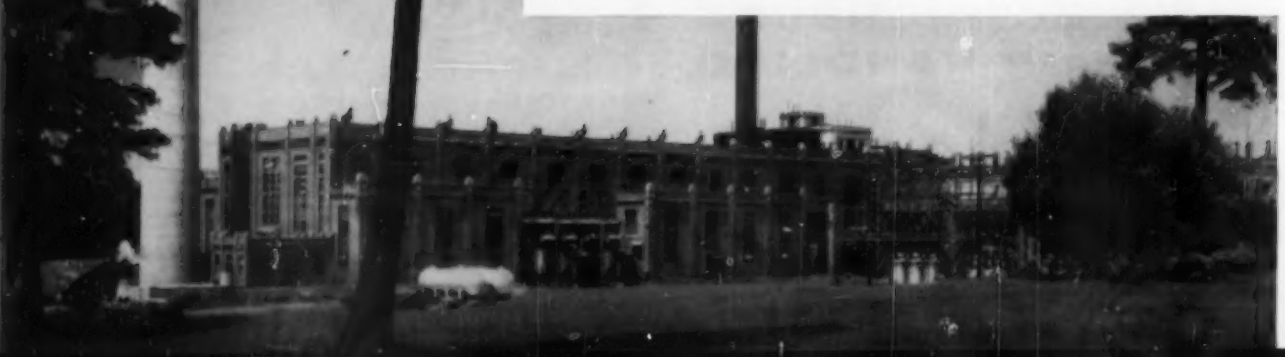


THE ALL-OUTDOOR Louis V. Sutton Steam Electric Generating Plant of the Carolina Power & Light Company at Wilmington, N. C. Copes-Vulcan Combustion Control, Boiler Feed Water Control, and Automatic-Sequential Soot Blowing help to maintain maximum boiler efficiency.

REPEAT ORDER for Copes-Vulcan Boiler Control and Pump Recirculation

from Carolina Power and Light Company for the Cape Fear Steam Electric Station

Copes-Vulcan maintains perpetual interest in every installation *after* it is in service. And throughout the life of the equipment, trained Copes-Vulcan servicemen will regularly visit the plant to check performance and see that everything is functioning as it should. If you'd like this attention on your jobs, give Copes-Vulcan a crack at the control and cleaning of your next boiler.



POWER FOR CAROLINA

At Carolina Power & Light Company's new outdoor installation, the Louis V. Sutton Steam Electric Generating Plant, steam is generated in two coal-fired boilers designed for 1750 psi at 1005 F. Unit 1 is a Combustion Engineering steam generator with a design load capacity of 950,000 pph. Unit 2 is a radiant-reheat Babcock & Wilcox boiler designed for 900,000 pph, with a reheat to 1005 F. Copes-Vulcan control helps keep these steam generators efficient.

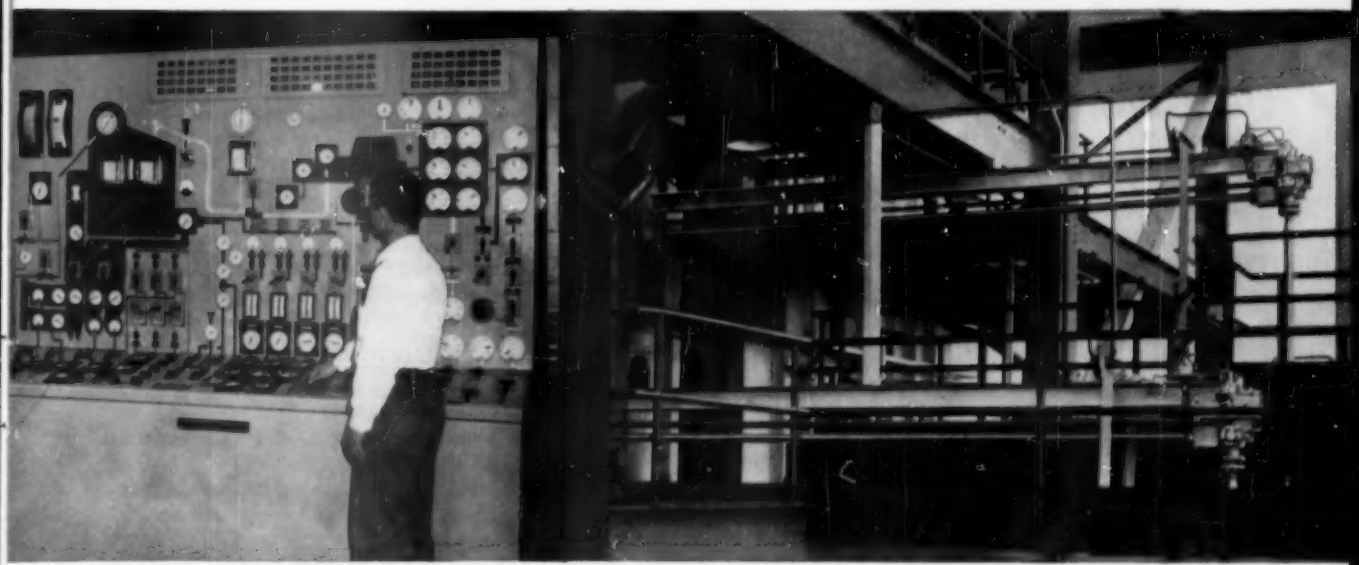
BOILER CONTROL

A Copes-Vulcan Combustion Control System accurately regulates the fuel and air for proper combustion. Copes Type 3-L Feed Water Control matches the feed flow to the steam demands and maintains a constant drum level. Copes provided 10-inch, 1500 pound standard motor-operated feed water by-pass control valves. Copes-Vulcan control and valves give automatic recirculation for protection of three boiler feed pumps.

BOILER CLEANING

The Vulcan Automatic-Sequential Soot Blowing thoroughly cleans the heating surfaces. Air is the blowing medium in both units. Air motors drive the blowers in Unit 1; Electric motors drive those in Unit 2. Cleaning elements include Vulcan long retractables, wall deslaggers, rotaries, and air preheater cleaning controls.

Write for complete information about Copes-Vulcan Boiler Controls and Soot Blowers.



COMPACT OPERATING PANEL. There is one operator in the central control room at the Louis V. Sutton Generating Plant.

DUAL-MOTOR DRIVE on these Vulcan Long Retractables and the Vulcan Wall Deslaggers give more complete cleaning than single-motor drive, leaving *no* surface unblown.

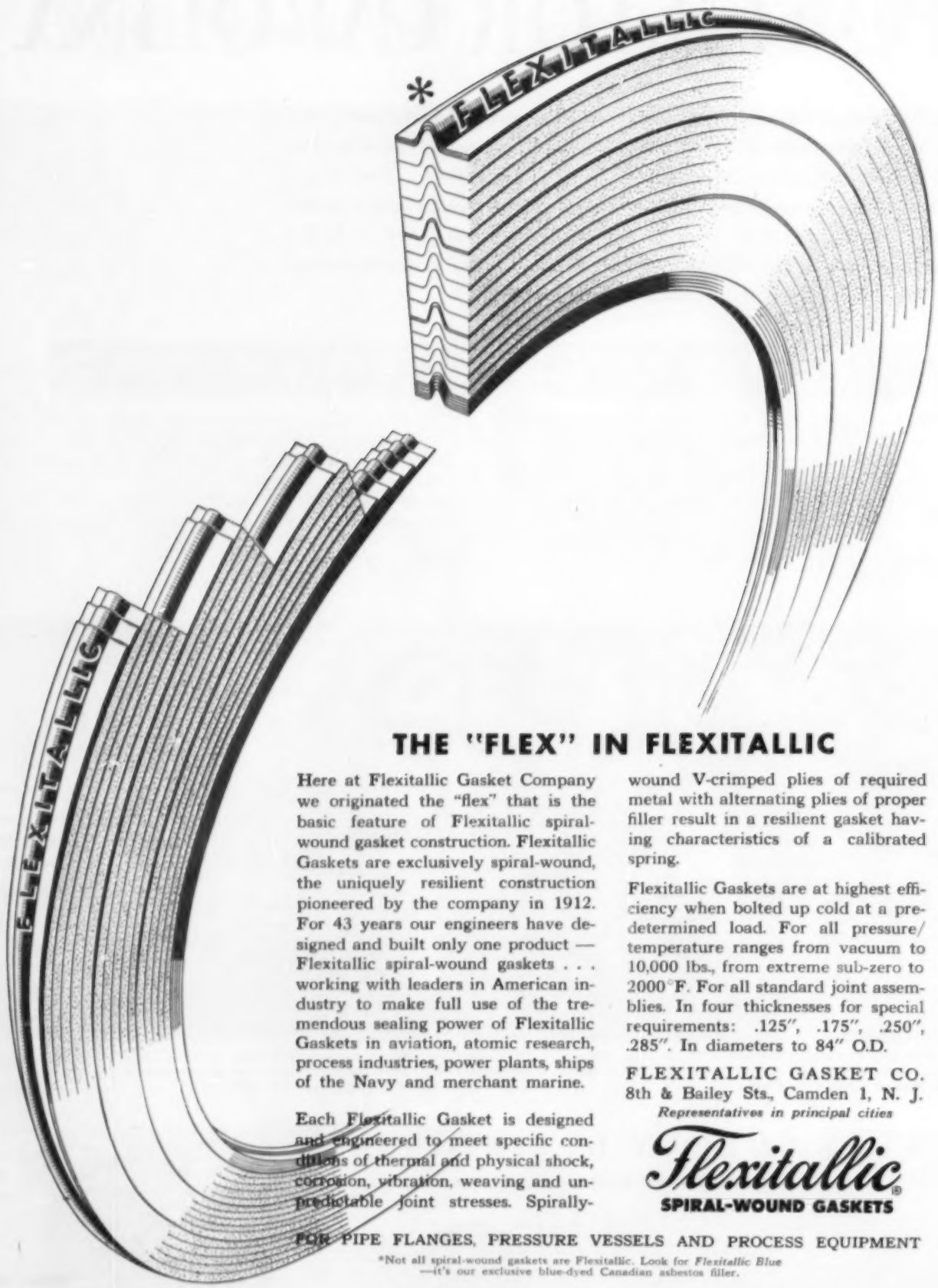
COPES-VULCAN DIVISION

CONTINENTAL FOUNDRY & MACHINE COMPANY

ERIE 4, PENNSYLVANIA

COPES VULCAN

We believe
ONLY THE HIGHEST QUALITY OF PRODUCT AND SERVICE TO OUR CUSTOMERS CAN BUILD A REPUTATION WORTHY OF OUR EFFORT.
Copes-Vulcan



THE "FLEX" IN FLEXITALLIC

Here at Flexitallic Gasket Company we originated the "flex" that is the basic feature of Flexitallic spiral-wound gasket construction. Flexitallic Gaskets are exclusively spiral-wound, the uniquely resilient construction pioneered by the company in 1912. For 43 years our engineers have designed and built only one product — Flexitallic spiral-wound gaskets . . . working with leaders in American industry to make full use of the tremendous sealing power of Flexitallic Gaskets in aviation, atomic research, process industries, power plants, ships of the Navy and merchant marine.

Each Flexitallic Gasket is designed and engineered to meet specific conditions of thermal and physical shock, corrosion, vibration, weaving and unpredictable joint stresses. Spirally-wound V-crimped plies of required metal with alternating plies of proper filler result in a resilient gasket having characteristics of a calibrated spring.

Flexitallic Gaskets are at highest efficiency when bolted up cold at a predetermined load. For all pressure/temperature ranges from vacuum to 10,000 lbs., from extreme sub-zero to 2000°F. For all standard joint assemblies. In four thicknesses for special requirements: .125", .175", .250", .285". In diameters to 84" O.D.

FLEXITALLIC GASKET CO.
8th & Bailey Sts., Camden 1, N. J.
Representatives in principal cities

Flexitallic®
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

*Not all spiral-wound gaskets are Flexitallic. Look for *Flexitallic Blue* —it's our exclusive blue-dyed Canadian asbestos filler.

Editorials

Publishing Engineering Information

In our last issue, May, p. 71, COMBUSTION published certain excerpts bearing on technical publishing from the remarks employed by Glenn B. Warren, vice president of the General Electric Co., in concluding his paper before the recent American Power Conference. These excerpted remarks, attempting broadly to fix the responsibility for publishing engineering information, were brief but singled out several highly crucial points which could profit from more attention by all concerned.

First, and foremost, is Mr. Warren's contention that the results of not more than a small fraction of our total industry-sponsored research and developmental results are published and, in his opinion, thereby greatly limit the rapidity of our advance along all fronts. This unfortunately is the case. Often the very individuals in charge of the research projects contribute to this situation. As Mr. Warren describes it "these scientists and engineers, themselves, are so busy and so heavily loaded by the complexities of their jobs that when a particular problem or job is solved they pass on to the next. . . . They do not pause to made a record for others of the path they have trod." Yet, in the final analysis, the responsibility for correcting this failing lies with top management. The technical press, by and large, will gladly publish the information if it is made available. Here the solution seems a clear-cut one and needs only favorable action on the part of industry's policy makers to correct the situation.

Mr. Warren's second major point—the responsibility of seeing that those who can profit from published material avail themselves of it—defies any quick or general solution. One of the problems so clearly recognized in Mr. Warren's comments is the paradox of a profusion of data and reports coming out in print on the one hand and a recognized inadequate coverage of known research and development programs on the other. This profusion makes it indeed difficult to find and assimilate the available information. Because of this difficulty the research and development man may question the effectiveness of the business publication as a means of disseminating research data. Frequently the technical press adds weight to this questioning viewpoint by confusing the issue without justification. We refer to a growing practice of picking up a given report or a paper for publication and then either drastically changing its title and, often, much of its content, so it appears to report on an entirely new set of data or altering the title enough so that a researcher compiling published data is led to expect either a supplementary report on the original or a different interpretation of the fundamental data. Worse yet some publications in the technical journal field commit both of these crimes and compound them with a failure to list a reference of any sort let alone a proper one to the original, full report.

Wanted: A Centripetal Professional Force

Just two years ago we published an editorial under this title in the hope of stimulating efforts toward an effective unity engineering organization. We are now reprinting this editorial, with minor changes to put it in proper time focus, in the renewed hope of directing attention to this currently slumbering area of cooperation among all engineers and the technical societies to which they belong.

When these words were written in June 1953 the American Medical Association was holding its 102nd Annual Meeting in New York City. More than sixteen thousand physicians were in attendance to hear some four hundred technical papers.

Why did we mention this in a publication whose readership is predominantly made up of engineers? If one considers the current state of organization, over-organization and disorganization of the engineering profession the answer will be apparent.

In September 1952, the American Society of Civil Engineers celebrated its Centennial with a mammoth intersociety meeting in Chicago. Looking back to a realistic appraisal of the meeting one is confounded by the almost incredible fragmentation of the engineering profession. Indeed, it would be difficult to find a better example of growth of professional provincialism and narrow specialization.

How can one explain the contrastingly different rôles that the AMA and the ASCE have come to assume in their respective professions? Actually, both societies had their origins at about the same time in the mid-nineteenth centrury and benefited by reasonably comparable advances in their basic underlying scientific disciplines. Yet despite the rapid growth of medical specialties and the divergent forces that such interests must have imposed upon the structure of the AMA, that society has continued to exert leadership for the entire medical profession. On the other hand the ASCE which originally represented civil, as contrasted with military, engineering, continued to represent one specialized field while innumerable other specialized societies sprang up over the years. This is not meant as a criticism of the ASCE but rather represents a long-continuing trend that has fragmented the engineering field.

Today the engineering profession might be compared to a rotating machine that is badly out of balance. The centrifugal forces of narrow specialization and the inertia of vested society interests have gotten out of hand. Engineers know what to do to bring the machine into balance. *Somehow* they must find and muster the strong and effective leadership that can create the centripetal forces out of which an effective unity organization can grow.

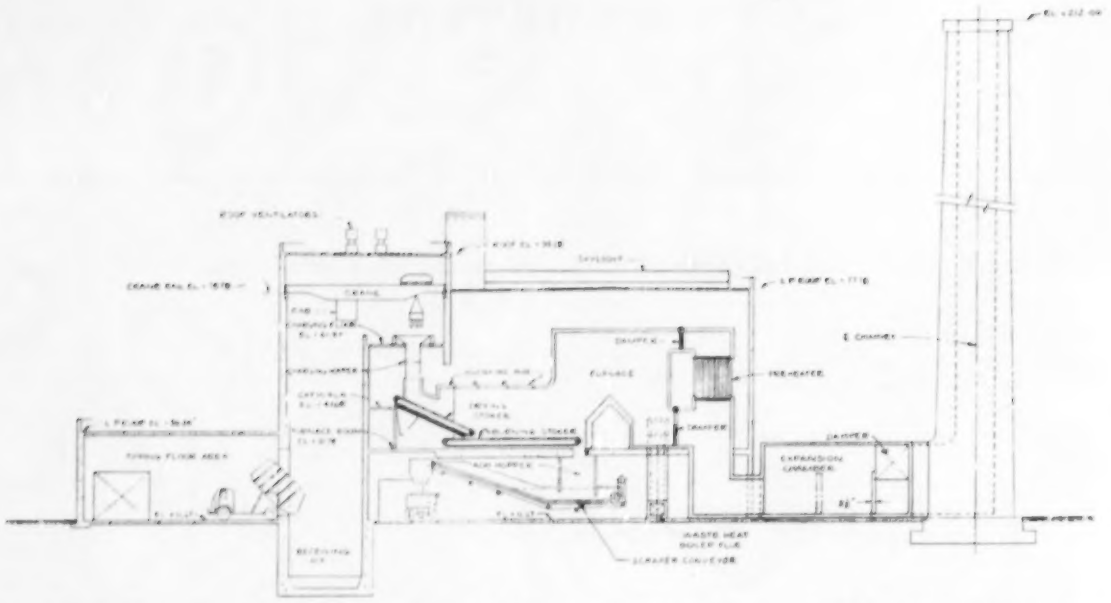


Fig. 1—Simplified sectional view through the South Shore Incinerator Plant, City of New York, illustrates relationship of different components making up a traveling grate stokered incinerator installation

Traveling Grates Find A New Field of Usefulness

By VIGGO WESTERGAARD*

Department of Public Works, New York, N. Y.

Incineration of the day-to-day combustible wastes, especially for large cities, has become a very sizable phase of municipal operations and requires the most up-to-date engineering and techniques for satisfactory results. Here is a description of New York City's answer to this problem.

THOUGH attempts to introduce automatic stoking by the use of traveling grates have been made with some success in a few cases in the past, the City of New York may, we believe, take credit for having built the first successful large scale incinerators using this type of stoker.

When in the latter part of the 1940's New York City embarked upon a record-breaking municipal incinerator construction program it decided that it would be well advised in developing its own type of incinerator suited to its own special needs. Fig. 1 is a simplified cross-sectional view of the most recent version of this development and shows the relationship of the components.

The traveling grate was chosen as the most direct means of transporting the refuse from the furnace feed opening to the residue drop. Further, New York City specified two separate stokers to be installed in each furnace, one above the other, so that a drop of the partially ignited material would take place during the burning process. The mixing of the burning and the as yet unignited refuse on the lower grate by the tumbling of the refuse from the drying stoker above to the burning stoker below has made stoking unnecessary except for leveling the fuel bed. Thus the back-breaking labor of heavy stoking and cleaning of the fires has, practically speaking, been eliminated by this new approach to incinerator furnace design.

The decision to increase the City's incinerator capacity to handle all its burnable refuse was a reversal of a policy adopted by the City Administration of the early 1930's which called for disposal in controlled landfills in preference to incineration. The realization that suitable areas for landfill were becoming scarce and that existing landfills were approaching completion in the foreseeable future made the adoption of an incinerator building program the logical step.

In an informative article "New York City Turns to Incineration" in *Civil Engineering*, December 1952, p. 54, C. A. Rogus, Director of Engineering in New York

* Project Engineer.

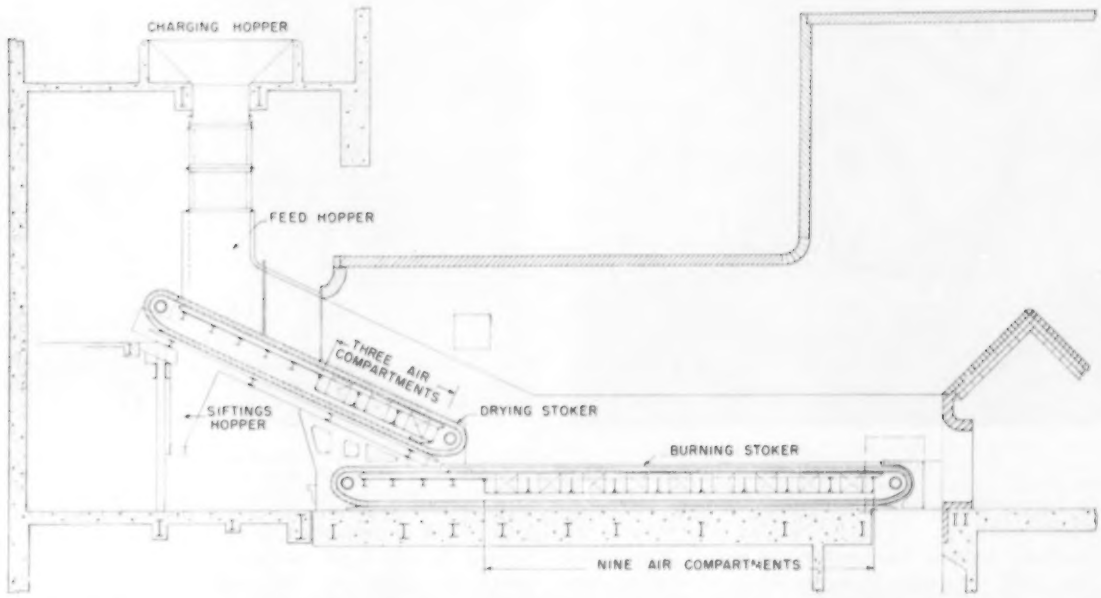


Fig. 2—Detailed cross-section of stoker arrangement for South Shore shows number of well-divided air compartments which contribute to effective control of combustion air throughout the grate area

City's Department of Sanitation, has described the basis for determining the number and capacities of the new incinerators as well as which of the existing plants should be modernized as part of this program.

Table I copied from the aforementioned article shows the estimated future quantities of the various categories of refuse the City must be prepared to collect and dispose of. 1970 has been chosen as the assumed leveling-off point in growth of population, which is expected to reach approximately 8,300,000. With an estimated daily incinerator load of 13,220 tons, the quantity per capita will be about 3.2 lb per day. This figure is somewhat higher than similar per capita quantities reported by other large American cities.

The construction program in tabulated form is shown in Table II.

The division of the estimated refuse quantities among the planned incinerators and the effort to standardize the furnace capacities as far as possible, accounts for the difference between the total of 13,220 tons per day installed capacity of Table II and 13,020 tons per day given in the last column of Table I. Some of the percentages given in the last column of Table I exceed 100 per cent. This means that during the periods of extreme high refuse quantities the incinerators will be operated above rated capacities. The slight deterioration in quality of the incinerator residue due to "pushing" the furnaces is permissible when, as in New York City, it will be disposed of in controlled landfills.

The estimated cost in capital outlay for the total construction program is in the neighborhood of $70,000,000.

Betts Avenue Plant

The Betts Avenue Incinerator was the first plant to be built under this program. Its rated burning capacity is 800 tons per day in four furnaces of 200 tons per day each. For full description of the features of this plant an article in *Civil Engineering*, April 1950, p. 17, "New York Builds Incinerator with 800-Ton Daily Capacity" by Hon. Frederick H. Zurmuhlen, Commissioner of New

TABLE I—ESTIMATED INPUT OF REFUSE INTO INCINERATORS IN 1970, IN TONS

Month	D.S. collected garbage & rubbish	Privately collected garbage & rubbish	D.S. coal ashes*	P.C. coal ashes*	Street sweepings	Street litter	Swill	From other city & fed. depts.	Total† per month	Total per‡ av. op. day	Percent of design total (13,020 tons per day)
January	226,200	43,700	18,400	2,500	8,225	4,175	15,050	2,900	321,150	12,430	95.3
February	216,700	51,900	17,000	2,070	8,225	4,375	17,850	3,780	321,900	12,450	95.5
March	254,700	66,000	13,800	1,730	8,475	4,700	17,100	3,900	370,405	14,330	110.0
April	202,700	68,200	8,400	1,315	8,725	4,800	18,150	3,750	316,040	12,240	93.8
May	226,200	75,400	2,700	1,130	8,725	4,700	19,225	3,530	341,610	13,210	103.0
June	232,200	80,700	2,000	1,050	8,850	5,700	21,325	3,850	355,675	13,760	105.5
July	206,200	72,700	1,300	795	8,725	5,625	21,225	3,430	320,000	12,380	95.0
August	206,000	76,000	1,300	795	8,725	5,450	21,350	4,010	323,630	12,520	96.2
September	202,200	68,900	2,700	1,140	8,700	4,800	21,325	3,750	313,515	12,130	93.2
October	250,200	68,700	5,000	1,300	8,700	4,700	19,200	2,570	360,370	13,930	106.8
November	238,600	59,500	10,600	1,675	8,475	4,800	18,150	14,350	356,150	13,790	105.6
December	228,100	46,300	16,800	2,500	8,450	4,175	15,050	2,680	324,055	12,550	96.3
Total	2,690,000	778,000	100,000	18,000	103,000	58,000	225,000	52,500	4,024,500		

* Coal ashes are assumed unsegregated amounts, 20 per cent of total domestic for D.S. collection and 10 per cent of the industrial coal-ash portion collected by private cartmen.

† Values shown per month are adjusted for an equivalent 30.41-day month (365/12).

‡ Values shown per day are adjusted daily requirements in recognition of the fact that incinerators operate on the average of 310 days per year.

TABLE II—INCINERATOR CONSTRUCTION PROGRAM

	Number	Installed capacity, tons per 24 hours
New incinerators:		
Completed and in operation	3	2,800
In design stage	1	1,000
Future	6	5,500*
Total for new incinerators	10	9,300
Rehabilitation of existing incinerators:		
Under construction	1	660
Future	4	3,260*
Total rehabilitated	5	3,920
Grand total	15	13,220

* Estimated quantities.

Fig. 3—South Shore Incinerator Plant, left, demonstrates clean lines, modern appearance of the present day designs for these installations. Color bands on chimneys plus special stack lighting gives aircraft protection

York City's Department of Public Works, is recommended.

The Betts Avenue Incinerator was placed in operation in May 1950. As must be expected in all new developments, some difficulties were experienced and corrected in the early months of operation. The important changes were to the feed hoppers, the arches and the stokers.

By changing the shape of the feed hopper a continuous and uninterrupted flow of refuse into the furnace through a vertical chute from the charging floor was achieved. This removed a serious obstacle to furnace operation caused by the tendency of the refuse to "hang-up" in the chutes as originally designed.

The selection of a rear arch over the burning stoker in the original furnace installations was based on the belief that the process of drying the refuse would prevent good combustion from taking place in the front of the furnace and that therefore the most intensive burning would occur on the rear half of the stoker surface after the refuse has been well dried out. The rear arch was intended to guide the hot gases toward the front as an aid in the drying out process. This concept was proven erroneous. By far the liveliest burning takes place at the front end of the furnaces where the easy-to-burn rubbish is largely consumed. The original Betts Avenue design thus left the garbage remnants under the rear arch without proper assistance from the heat produced by the burning rubbish; the hot gases escaping into the combustion chamber without passing over the rest of the grate areas. Poor burning on this part of the grate resulted. When the furnaces were modified to simulate the front arch principle there was a marked improvement in furnace capacity and good burning was achieved over the entire grate area.

Slag buildup on the furnace walls was another source of trouble on this Betts Avenue installation. This slagging problem proved most acute where the drying stoker discharged onto the burning stoker. Studies of this problem led to a solution which was applied at the later Gansevoort and South Shore incinerator plants. It involved substituting an air-cooled carborundum brick for the originally specified furnace wall refractory in the areas most affected. This substitution has greatly reduced slagging difficulties in these later installations.

In the Betts Avenue Incinerator the stokers are of the chain grate type with chrome cast iron links. The motion of the grate surface in this type of stoker is transmitted directly from the drive shaft to the grate surface and every single grate link must sustain its share of the force required for the forward motion of the grate.

Because of the presence in the fuel of a large proportion of metal objects of all sizes and shapes, Fig. 4, and a considerable amount of aluminum and white metals, link breakage, caused by metal objects like wire and molten metal wedging between successive links, became so serious as to markedly interfere with plant production. A number of breaks, beginning with a few links at one side, would "chain-react" across the surface and cause a complete separation of the grate surface. This would not only leave the plant operator with a substantial repair job, but also with a furnace full of burning material that could not be "dumped" and this, in turn, raised the problem of preventing the fire from propagating up through the feed hopper. The difficulty was solved by replacing all the links running over the six drive sprockets with cast steel links thus creating a series of barriers against rupture across the grate surface.

Gansevoort Plant

The 1000 ton per day Gansevoort Incinerator, with four 250 ton per day furnaces, was placed in operation in May 1953. The stokers in these furnaces furnished by Illinois Stoker Co., were also of the chain grate type, but supplied with cast steel links entirely. The links were designed especially to minimize the possibility of metals wedging between successive links, and no link breakage has occurred. Metals melting on the grate have, however, a tendency to harden in the air spaces between adjacent links and are troublesome to remove when the reduction in free air space area makes this operation necessary.

South Shore Plant

In August 1954 the South Shore Incinerator, Fig. 3, was opened and began operating. This, the third of the new plants, was also designed to burn 1000 tons in four furnaces each of 250 tons in 24 hours capacity. Combustion Engineering, Inc. furnished the stokers for this plant.

The bar and key type traveling grates installed differ

Fig. 4—Metal objects such as those to the rear of this photo are standard constitituents of New York City's incinerator fuel. These have been removed from a burning stoker through the stoking or rear furnace doors

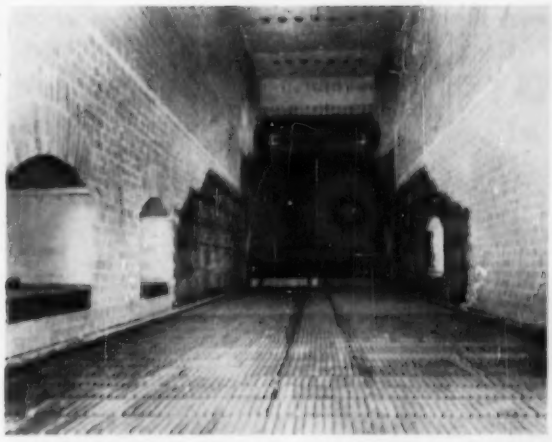


Fig. 5—Inside view of the furnace shows marked angle of incline of drying stoker to the horizontal burning stoker. This last named travels at higher speed than drying stoker so fuel bed is kept relatively thin

from the chain grate type of the two previous plants in that the forward motion is transmitted by four endless chains upon which are mounted the structures carrying the keys which form the grate surface. The keys are thus under no other mechanical stress than that produced by the weight of the fuel bed and the action of the fuel upon the grate structure. It was decided as an experiment to use chrome cast iron instead of cast steel keys, both because of the lesser cost of cast iron and also because of other properties which makes it more desirable for furnace grates and similar applications. Operating experience during the past few months seems to indicate that it was a well made choice. Though occasionally a key does break, it is quite easily replaced.

The difficulties experienced with molten metals congealing between the cast steel links mentioned above are not a problem. Metals hardening on the cast iron keys do not seem to adhere to the keys and can be lifted off with a screwdriver. Final judgment on the relative merits of the chain grate with cast steel links versus the bar and key grate with chrome cast iron keys must, of course, await the accumulation of more operating experience. Both types are now operating satisfactorily.

As stated above each of the four furnaces at South Shore has two independently operated stokers arranged in "tandem" (Figs. 1, 2, 5). The first, or "drying stoker" Figs. 1, 2, is placed at an angle of 25 degrees to the horizontal with its discharge end 32 inches above the "burning stoker," which is horizontal. The stokers are 8 feet wide inside furnace walls, Fig. 5. The drying stoker is 22 feet between front and rear shafts and has an effective burning length of 10 feet 6 inches. The burning stoker is 38 feet between shafts and its effective burning length is 29 feet 9 inches. Both stokers are driven through their rear shafts by independent 5 horsepower, constant speed, electric motors, variable speed drives and double worm gear reducers, at speeds adjustable between 12.5 and 150 feet per hour.

The refuse is fed to the furnace through a vertical chute, Fig. 7, from the charging floor, Fig. 6, located about 15 feet above the drying stoker. The chute is 8 feet wide and 4 feet across. From the vertical drop the refuse travels approximately 6 feet on the drying stoker in a continuation of the feed chute which still measures 8 feet in width and 4 feet above the stoker surface. The refuse is thus conveyed to the furnace without any change in chute dimensions through the direction of travel changes from vertical through 115 degrees to the slope of the drying stoker. This feeding arrangement has proven fully reliable and assures uninterrupted flow of refuse to the furnaces at the rate determined by the speed of the drying stoker throughout the periods of operation. The inclined section and approximately eight feet of the vertical chute are water cooled. This was found necessary since the fire in the furnace will slowly propagate back into the feed chute whenever the drying stoker is stopped during burning periods. The design of the feed chutes permits the operators of the cranes, which are located above the charging floor, to keep the charging hoppers constantly filled.

The material in the feed chute provides an effective air seal. Seal plates and shoes are provided in the space between the drying and burning stokers. Since the residue is disposed of through water sealed quenching hoppers, the furnaces are effectively sealed and the excess air is controllable within definite limits. The residue is removed from the quenching hoppers by partially submerged inclined scraper conveyors to trucks and hence to final disposal on landfills.

A few changes were made in the standard stoker design to adapt it to a fuel of certain unusual qualities as far as traveling grate operation goes. Possibly the most interesting of these is the introduction of a forced draft compartment around the rear shaft assembly of the drying stoker. The position of this mechanism, exposed in the hot zone of combustion, made it desirable to provide means of making sure that the temperatures of the moving parts could at all times be kept within safe operating limits. The air supply to this area is independently controlled by a sliding damper in the partition to the adjacent standard undergrate air compartment. Forced draft is otherwise admitted through individually dampered air compartments, Fig. 2, located between the upper and lower strands of the grate surfaces. Nine compart-

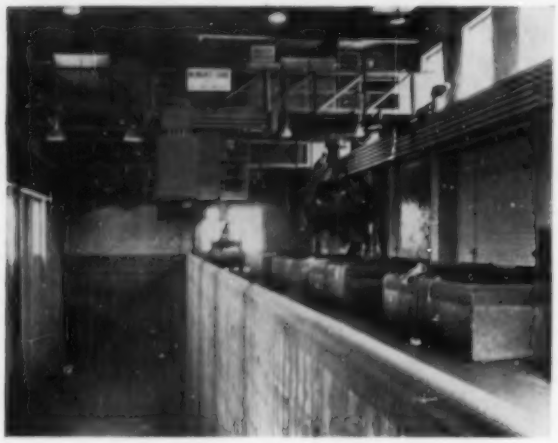


Fig. 6—View of charging floor as one ton of refuse in grab bucket is swung into position above a furnace feed hopper which is about 15 ft above drying stoker

Fig. 7—Charging chutes meet up with the drying stoker in the manner shown above. Since size of feed chute is constant drying stoker speed controls the rate of feed

ments, Fig. 2, in the burning stoker and four in the drying stoker, control air to practically the entire effective burning length of the stokers. Because of the prevalence of metal of low melting point, the bottom plates of the air compartments are made replaceable in case heavy deposits of hot metals should cause undue warping.

The stokers are designed so that they may operate on preheated air up to 400 F. Because of the nature of present day city refuse, preheat has proven unnecessary and may not be included in the design of future plants.

Both shafts of the drying and burning stokers are of the trunion type with take-ups at the front ends. The rear shafts of both stokers are water cooled.

The fine ash produced by burning city refuse has been found to have unusual abrasive qualities, beyond any experienced with ordinary solid fuels. Heavy abrasion therefore is a problem in this field of stoker service and must receive serious consideration in the design of the equipment. The replaceable cast iron wearing shoes bolted to each chain link of the four driving chains will undoubtedly materially increase the life of the understructures. Inspection shows an even wear across the surfaces of the shoes and little evidence of wear on the steel rails on which they ride.

At the beginning of an operating cycle the first bucket loads of refuse are dropped through the empty chutes directly upon the grate surfaces. As the refuse contains heavy metal objects, the impact upon the grate may be of quite some magnitude. For this reason a stronger than usual understructure was designed for this installation. The stoker frame is made entirely of steel of welded and bolted construction.

The furnaces operate between five and six days every week of the year on a 24 hour basis. They are shut down over week ends to permit removal of settled flyash from the flues and the expansion chambers and to clean the receiving pit.

The stokers are generally operated at considerable divergence in speed, the burning stoker being mostly run about 25 per cent faster than the drying stoker. The speed of the drying stoker determines the quantity of refuse fed to the furnace since the feed opening into the

Fig. 8—Operating floor above pictures the row of forced draft air compartments under the burning stoker, the drive for the inclined drying stoker, left

Fig. 9—Furnace operating instrument board, right, is at the level of the burning stoker and, at its front end, the inclined drying stoker is seen above the burning stoker

furnace is constant in size. The fuel bed is four feet thick at the entrance to the furnace. By operating the burning stoker at a higher rate, the remaining fuel is spread thinner over the grate surface, resulting in better contact of combustion air with the less easily burnt remnants of the garbage.

Furnace instruments and equipment control stations are grouped together on the operating instrument boards, Fig. 9, one for each furnace, located at the front end of the burning stokers. Each contains in addition to the electric motor start and stop buttons, draft gages and pyrometers. The vertically reading draft gages show pressures in the forced draft duct and in each air compartment, and the draft in the furnace above the burning stoker and in the flue connecting the expansion chamber to the chimney. The pyrometers indicate furnace and chimney temperatures and record furnace and forced draft temperatures. The main furnace damper located at the entrance to the chimney flue, is operated by an electric motor winch. Push buttons for operating the damper are located on the operating instrument board, which also contains an indicator showing the position of the damper from fully open to closed.

The South Shore Incinerator is built in the salt marshes at Jamaica Bay and the incinerator residue is used as uncovered fill around the plant. The absence of odors from the fill testifies to the good burning qualities of the furnaces. The burning rate on the stokers is better than 70 lb of refuse per hour per square foot of the combined gross effective grate areas of both the drying and the burning stokers. The furnaces operate at capacities that average above their ratings.

Some of the advantages of an incinerator with furnaces incorporating traveling grates or similar automatic stokers may be enumerated as follows:

(*a*) Less heavy labor involved in stoking the furnaces and cleaning fires.

(*b*) Decrease in man-hours on the stoking floor. In dollars and cents this will of course be more apparent in larger plants.

(*c*) Steadier furnace temperatures because of closer control of air admission to the furnace. This is due to the continuous, sealed, refuse charging and residue removal possible in this type of furnace.

(*d*) Reduction in thermal shocks to the brickwork because of the well-restrained admission of cold air as accomplished under (*c*). This should pay off in longer refractory life.

(*e*) Better control over flyash emission from the chimney. This again may be ascribed to the relative absence of the brief but strong air currents arising in the furnace and carrying through the combustion chamber, flues and expansion chamber whenever the furnace is opened. The momentary increase in gas velocity will of course prevent some flyash from settling and will also stir up and re-entrain in the gas stream some of the matter already captured.

Against these points favoring the traveling grate type incinerator furnace should be entered the disadvantages some of which are as follows:

(*a*) The higher capital cost of these plants.

(*b*) The obvious requirement of more expert supervision and maintenance. The penalty for neglecting these will unquestionably result in a considerable increase in ultimate maintenance cost which will whittle away some of advantages indicated above.

The City's experience with its three new traveling grate stokered incinerators has convinced it of the excellent burning qualities of this type furnaces. Based on this experience the City has approved Combustion Engineering, Inc. bar and key type traveling stokers for the three 220 ton per day furnaces in the East 73rd Street Incinerator now under construction. Traveling grates of either type are also being specified for the new 1000 ton per day Greenpoint Incinerator on which construction is expected to get under way late this spring.

The design and construction of New York City's incinerators is a function of the Division of Sewage Disposal in the Department of Public Works under the guidance of Commissioner Frederick H. Zurmuhlen. William A. O'Leary is Director of the Division, S. W. Steffensen is Chief of the Bureau of Design and A. R. Glock is Chief of the Bureau of Construction. The South Shore Incinerator, as other completed incinerators, is now under jurisdiction of, and is being operated by the Department of Sanitation, Hon. Andrew W. Mulrain, Commissioner.

Industry Plans $300 Million Investment in Atomic Research

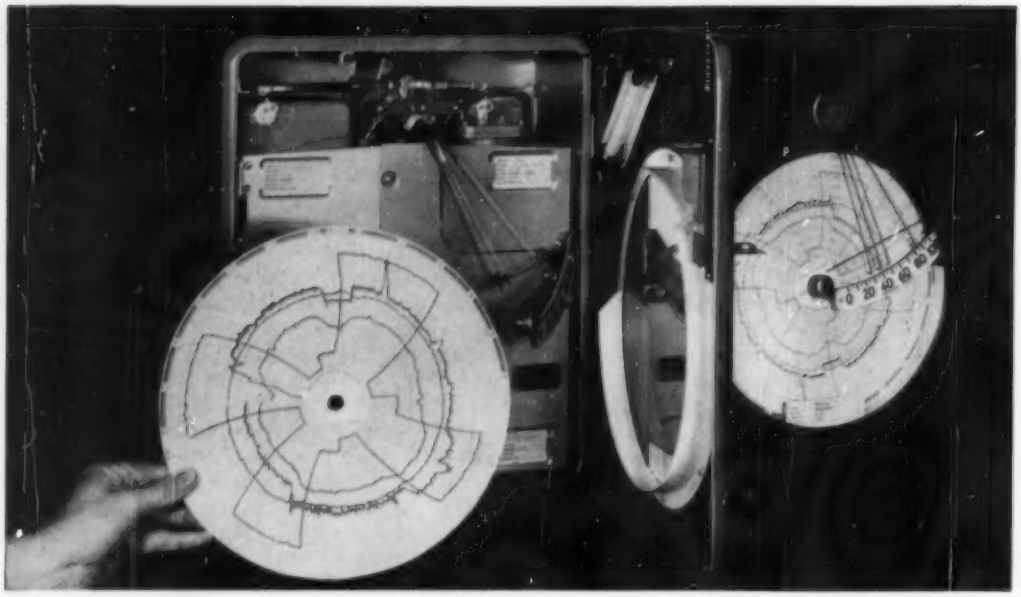
By 1959 manufacturers, electric power companies, research institutions and other non-government organizations will spend approximately $300 million of their own money on atomic energy research, according to a report by the Atomic Industrial Forum, Inc.

This report states between three and five million kilowatts of electric capacity may have to be built and operated on an uneconomic or break-even basis before reactor-generated electric power can become competitive with conventional power, expected some time after 1962.

In 1963, the manufacture of components for reactor plants may be over a $700 million a year business. Up to that time or perhaps until 1965, the largest equipment markets will be in propulsion reactors for submarines and perhaps other naval vessels and aircraft.

By 1965, however, it is expected that more than $7.5 billion will have been invested in the U. S. on reactor construction. The operation of these reactors will call for an annual consumption of 8000 metric tons of natural uranium, including 26 tons in the form of enriched uranium 235. In addition atomic energy developments, both government and private, will call for a total of 30,000 to 40,000 scientists and engineers or about double the number in both categories today.

The data reported here came from more than 400 private organizations out of a total of 1000 solicited. The 400 organizations are estimated to comprise 75 per cent of the total private U. S. atomic energy industry from a dollar volume point of view. Additional data came from AEC files and from interviews with top authorities of government and industry in atomic power development.



Faithfully yours –

Clear, Continuous Records without Poisoning . . . on the New Bailey Recorder

★ Faithful chart records of measured variables are the key to a meaningful, dependable analysis of operating trends and conditions. Money spent for more accurate metering, for faster response, is money down the drain—*unless* it's matched with chart records that are equally accurate.

That's why these features of the new Bailey Recorder are important to you:

1. Bailey's exclusive sealed capillary-action inking system maintains continuous flow to the pen tip, and traces sharp, opaque, quick-drying records. "Poisoning" of intersecting records is practically eliminated; no blots or smears during operation or chart changing.

2. Pens are mounted on concentric centers, trace on parallel time arcs only 42/1000" apart. This simplifies analysis of two or more records.

3. Interchangeable plug-in receiver units permit practically limitless record-grouping combinations

Write for Product Specification E12-5 and actual chart sample.

PBZ-1

ONLY BAILEY OFFERS ALL THESE ADVANTAGES IN A SINGLE RECORDER

- Pre-calibrated plug-in receiver units
- Up to four pneumatic or electronic receivers —or two receivers and two integrators
- Any four variables on one chart—easily read and interpreted
- A full year's ink supply at one loading
- Faster shipment—from stock
- Minimum inventory of parts
- Minimum instrument investment for process cycle expansion or alteration

BAILEY METER COMPANY
1025 IVANHOE ROAD
CLEVELAND 10, OHIO
Controls for Power and Process

BAILEY METERS
Controls for
TEMPERATURE
PRESSURE
GAS ANALYSIS
FLOW · LEVEL
RATIO · DENSITY

The Cost of Steam-Electric Power*

By H. E. ROBERTS*

Bureau of Power, Federal Power Commission†

The year-after-year records of achievement established by the public utility industry merit occasional review to realize better the truly remarkable progress in steam power production. The following article performs this review and aided by several illuminating charts and tables pictures the progress over a span of years.

THE total or overall cost of producing steam-electric power has been of absorbing interest to those responsible for such production for many years. Today, approaching the commercial possibilities of atomic power applications, this interest has been greatly intensified. The nuclear reactor, when proved to be practical through actual operation, will begin to replace the conventional steam boiler for the turbine steam supply only when its total costs are competitive with the like costs for conventional methods.

What is the total cost of producing steam-electric power and what are the elements or components of cost? What are the general relationships of these components to each other and to the whole? The purpose of this paper is to review and explore, to a limited extent, the subject of conventional steam power costs of the privately-owned electric systems as they are defined today. It is appropriate to present at the same time a brief resumé of 50-years' progress in the art of steam power production, the objective of which has been to control and where possible to reduce costs. Commonly used cost indices indicate that during this 50-year period the cost of the basic materials, labor and fuels required for the construction and operation of production facilities have increased over 600 per cent. With this thought in mind the results of 50-years' experience in steam power production are without question quite remarkable.

In the study and analysis of power costs it should be kept in mind that there are no two identical electric power systems. The corporate organization, management policies, the location, size and nature of operations and the availability of, or the absence of, hydro power all have significant bearing on the cost of doing business. The total cost of producing steam-electric power is, for most electric utility systems, one of the more important expense items in the cost of doing business.

Difference in design features, construction methods and operating procedures affect costs. There are many steam power plants of generally similar design and of about equal size yet no two are similar in all respects. However, today most plants do have one important aspect in common, that is operation in an interconnected, integrated system which includes several plants. In the system the most efficient plant with the lowest fuel cost normally operates at the highest annual plant factor or in other words it produces the most kilowatt-hours per kilowatt of capacity.

The generally uniform accounting methods used by the electric power industry throughout the United States for the past two decades makes it possible to take up the subject of costs on a common denominator level. This is most helpful particularly from the viewpoint of comparative cost analyses.

Major Cost Items

The total or overall cost of steam-electric power produced for delivery to an electric utility system is made up of two principal components: (1) Production Costs (expenses) (2) Fixed Charges on the investment in the production facilities.

A third component of relatively minor significance is an overhead item of allocated expense, usually designated as "Administrative and General Expenses." It may be included in the major components or set out as a separate component. In any event its omission or inclusion should be stated.

Production Costs represent the out-of-pocket expenditures for the labor, including supervision and engineering, the materials and supplies, fuel and miscellaneous expenses incurred in the operation and maintenance of the plant. Under present day accounting procedures such costs are readily determined on a generally consistent basis from the operating records.

Fixed Charges are related to the capital investment in plant and usually contain the following:

Cost of money (interest costs)
Depreciation
Taxes
Insurance (a minor item which is sometimes included in the other components).

Although fixed charges are just as much a part of the total cost of power as the production costs, they are not so readily or exactly determined. In most instances it is essential to make estimates and allocations to formulate fixed charges that are properly applicable to power production facilities. The average utility owns production, transmission, distribution, utilization and general service facilities. Management's first concern is to see that it earns the fixed charges on the total investment in all facilities. The accounting records for these cost items are maintained accordingly. For example, the underlying mortgage for the corporate bonded indebtedness ordinarily covers all of the facilities, not any one functional group. It is obvious that sound judgment must be exercised in estimating the appropriate fixed charges for the production facilities. The total annual fixed charges on the investment will, in general, range

* Cost Engineer.

† The Federal Power Commission, as a matter of policy, disclaims responsibility for any private publication by any of its employees. The views expressed herein are those of the author and do not necessarily reflect the views of the Commission.

TABLE I—TOTAL COST OF PRODUCING STEAM-ELECTRIC POWER[1]

	Mills Per Net Kilowatt-hour					
	1953	1952	1951	1950	1949	1940
Production costs						
Operating labor, Supplies, etc.	0.64	0.66	0.65	0.69	0.75	0.67
Maintenance (labor, materials)	0.50	0.53	0.53	0.56	0.63	0.41
Total operation and maintenance (excluding Fuel)	1.14	1.19	1.18	1.25	1.38	1.08
Fuel	3.33	3.38	3.42	3.49	3.73	2.20
Total Production costs (actual)	4.47	4.57	4.60	4.74	5.11	3.28
Estimated fixed charges	3.13	3.03	2.95	2.96	2.95	3.36
Total	7.60	7.60	7.55	7.70	8.06	6.64
Allocated administrative & general expenses	0.23	0.24	0.24	0.25	0.28	0.22
Total estimated cost of power (for delivery to systems)	7.83	7.84	7.79	7.95	8.34	6.86
Approximate annual plant factors, %	60	60	60	65	55	40
Fuel cost—cents per million Btu	25.2	25.0	24.9	24.8	25.2	—
Total cost of plants—million, $	7,533	6,495	5,880	4,460	4,064	2,369
Total capacity—million MW (name-plate)	56.8	51.7	47.2	42.6	38.1	25.2
Average cost per kw (name-plate), $	125	121	118	114	108	96

[1] Based on data taken from the Federal Power Commission's annual reports "Statistics of Electric Utilities in the United States—Privately-owned," and "Steam Electric Plant Construction Cost and Annual Production Expenses."

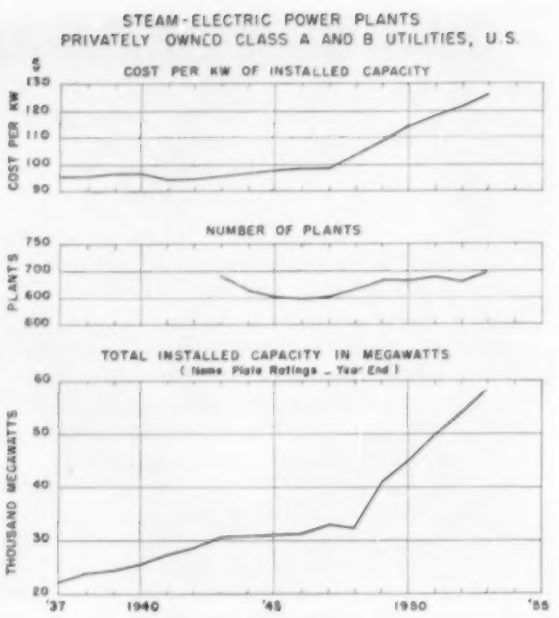


Fig. 1—Seventeen year period, 1937–1953, inclusive, show a decided rise in installed public utility capacity and cost per unit of capacity in the latter years.

between 10 per cent and 15 per cent depending on several factors and numerous conditions.

"Administrative and General Expenses" are in a general overhead category. They include such items as executive and general management salaries and related expenses, legal and regulatory expenses, pensions, and other similar items. These costs are applicable to the undertaking as a whole and the usual accounting procedures call for accumulating them as an overhead expense without allocation to the principal functions. In order to determine, for evaluation purposes, the total cost of producing power a portion of such expense may be allocated thereto on a reasonable and consistent basis. As previously mentioned this is a minor cost component and will probably fluctuate somewhat widely. A reasonable figure for estimating purposes would be within the approximate limits of 15 per cent to 25 per cent of the total annual production costs, exclusive of fuel costs.

Defining Cost Figures

Occasionally some confusion results from the terminology used in speaking or writing about power costs. The use of the general loose expression "production cost of power" or "cost of producing power" to designate the total (overall) cost of producing power for delivery to the system has been responsible for misinterpretations and confusion at times. Costs whenever referred to should be so defined or designated that they indicate clearly and definitely the components that are included or excluded so that the reader clearly understands what the writer has in mind.

When the total cost of power is determined there are, for different uses, various methods of expression. The most commonly used, which will be used in illustrations herein, is "mills per net kilowatt-hour" produced for delivery to the system. A second and common form divides the total cost between a "capacity" cost stated in terms of dollars per kilowatt per year or month and an "energy" cost stated in mills per kilowatt-hour. In turn, these are sometimes referred to as "fixed" and "variable" cost categories. To complicate matters the former may contain in addition to the "Fixed Charges" a part of the "Production Costs" because they are incurred irrespective of the kilowatt-hour production.

The summary tabulation, Table I, illustrates the determination of the total cost of producing steam-electric power on the kilowatt-hour unit cost basis. It gives the average cost per net kilowatt-hour and related statistical data for the total steam-electric power produced by the Class A and B privately-owned utilities for the most recent five-year period for which data are available and also, for comparison, the last pre-war year. Production costs are actual as reported. Fixed charges are predicated on an estimated 12½ per cent of total investment with depreciation computed on a sinking fund basis. "Administrative and General Expenses" have been estimated at 20 per cent of the "Production Costs, Exclusive of Fuel." These two percentages appear to be reasonable for the purposes at hand but no claim is made as to their specific applicability for any one system or group of systems.

These costs are significant only in one respect and they should be so considered. They represent the nation-wide average costs of the private companies for the specific years. All plants, large and small, efficient and the most inefficient are included. The unit costs are of value only for general comparisons. The following general relationships are developed:

(1) Estimated Fixed Charges are approximately 40 per cent of Total Costs, exclusive of "Administrative and General Expenses."

(2) Production Costs are about 60 per cent of the same total.

(3) Fuel Costs are about 45 per cent of the Total Costs, exclusive of "Administrative and General Expenses" and 75 per cent of the

TABLE II—TOTAL COST OF PRODUCING STEAM-ELECTRIC POWER[1]

	—Mills Per Net Kilowatt-hour—1953—		
	Coal	Oil	Natural Gas
Production Costs			
Operating labor, supplies, etc.	0.16	0.44	0.14
Maintenance (labor & materials)	0.18	0.32	0.10
Total operation & maintenance (excluding fuel)	0.34	0.76	0.24
Fuel	1.36	3.62	1.14
Total production costs (actual)	1.70	4.38	1.38
Estimated fixed charges	1.93	2.39	1.47
Total	3.63	6.77	2.85
Allocated administrative & general expenses	0.07	0.15	0.05
Total estimated cost of power (for delivery to systems)	3.70	6.92	3.00
Fuel costs—cents per million Btu	12	30	9½
Heat rate—Btu per net kwh	11,511	11,997	11,951

[1] Actual figures for three specific, large, postwar, low-cost plants for comparison purposes against Table I data. Each of the three principal fuels is represented.

Production Costs as shown in Table I.

(4) Operation and Maintenance, less Fuel, is about 15 per cent of the Total Costs before allocated overheads.

(5) "Administrative and General Expenses" are about 3 per cent of Total Costs.

At this point it is desirable to point out that the costs are exclusive of the costs of the plant step-up substation. Such costs are chargeable to transmission costs.

As a matter of interest and to show the spread between national averages and specific costs the corresponding costs for three large, postwar, low "Total Cost" plants during 1953 are given in Table II. Each of the three principal fuels is represented.

All three of these plants were operated at high plant factors. The oil-fired plant had the lowest plant factor of the group. Therefore, its "Fixed Charges" are somewhat higher for this reason as are "Operation and Maintenance Costs". Too, single year maintenance costs are not usually representative costs for a single plant. Of the 695 reporting plants there were 85 with better heat rates. The real significance is found in the cost of the fuel delivered at plant. Therein is the inherent major advantage enjoyed by some plants due to location. Each year brings into service more efficient plants and the above picture will be improved from year to year. That is the established record of the industry.

Plant Investigation

Fig. 1 shows, graphically, the number of steam plants, total installed capacity (name-plate rating) and the average investment cost per kilowatt for the Class A and B privately-owned utilities for the seventeen-year period, 1937 to 1953, inclusive. Comprehensive data for the industry are not available for earlier years. These costs are historical average costs that include expenditures for each year since 1900. Good plant sites are retained and re-used as are some of the structures or parts of structures.

During the 20-year period, 1920 to 1940, typical large multiple unit plants were built at an average cost of about $100 per kilowatt (name-plate) of installed capacity. There were variations of considerable magnitude below and above the average.

Construction costs, generally speaking, have doubled since 1939–1940. The electric power industry, through technological progress and the willingness to accept drastic changes, has been able to neutralize some of this advance and to hold down the construction cost of the

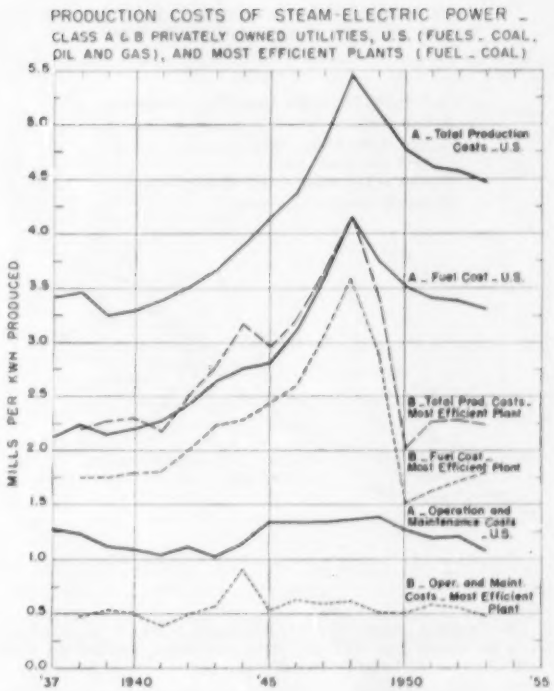


Fig. 2—Production costs of all reported Class A, privately owned utilities make up the curves labeled A, above, while the curves labeled B are the records for the most efficient plant of each particular year.

large, modern, post-war, multiple-unit plant to about $150 per kilowatt (name-plate). Again there are many cases of sizable cost variations. It is not unreasonable to use these two approximations, $100 and $150 as generally indicative of the two eras.

The $150 cost may be broken down as follows for major plant items:

Land and Improvements	$ 2.00
Structures	30.00
Boiler plant equipment	60.00
Turbine-generator equipment	45.00
Accessory electric equipment	10.00
Misc. power plant equipment	3.00
Total-per kilowatt	$150.00

These account totals are fairly representative However, there can be considerable variation depending on location, type of plant building, fuel burned, circulating water facilities required and similar items.

Various cost studies of new large coal burning plants indicate that 45 per cent to 50 per cent of the total cost is chargeable to the production of steam, i.e., the boiler plant equipment, boiler plant structures and associated miscellaneous equipment. In other words, this represents the investment in the portion of the plant that would be replaced by a nuclear reactor. The same percentage for a gas-burning plant will be somewhat less as the coal-handling, storage and pulverizing equipment represent a substantial investment.

Production Costs—Operation and Maintenance

Fig. 2 presents the production costs for the steam

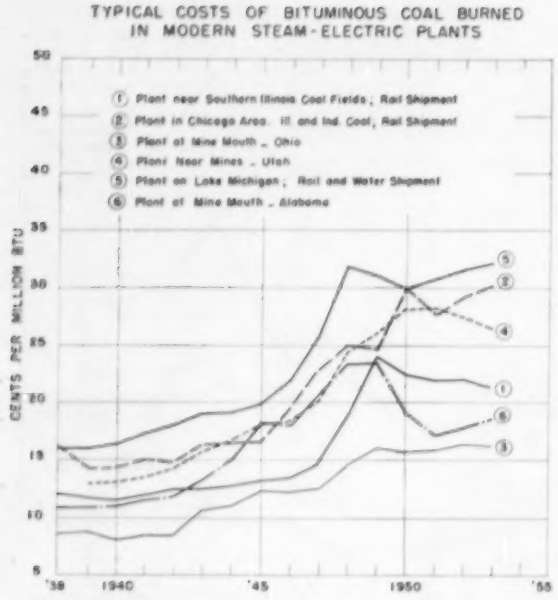


Fig. 3—Typical costs for bituminous burned in modern plants in cents per million Btu delivered, including coal handling.

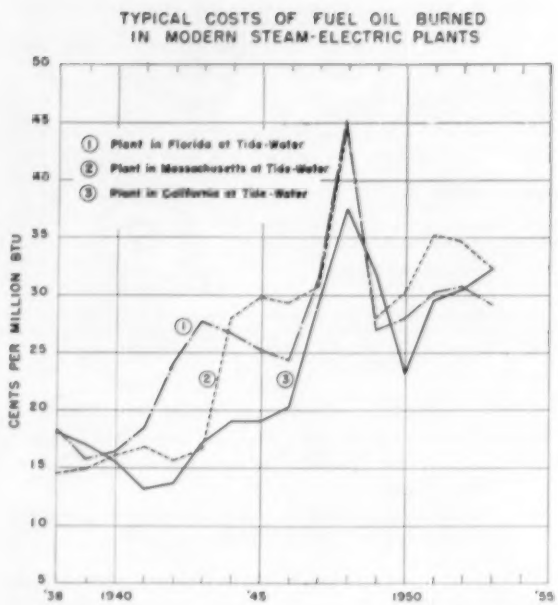


Fig. 4—Typical costs for fuel oil in modern plants in cents per million Btu delivered, including handling costs.

plants in Fig. 1, 1937 to 1953, inclusive. Also included are the same costs, year by year, for the most efficient but not necessarily the lowest total cost plant with a full year's operations. It is observed that over an extended period of years these costs, fuel excluded, have remained relatively stable.

The man-power savings accomplished in plant operating crews during the past 10 to 15 years through unit type construction (one boiler per turbine-generator unit), increased unit size, central control rooms, automatic controls, one and two level operation and new coal-handling equipment are outstanding. A few of the very large post-war plants have reduced operating personnel on a unit basis as much as 65 per cent over the corresponding large plant of the late 1920's. Fifty per cent man-power savings can be taken as a more representative figure. But it must be kept in mind that these man-power savings are to a large extent offset by the increase in wage levels since World War II.

Little can be expected in the reduction of maintenance costs which today account for about 45 per cent of the total. Metal products and skilled labor account for most of this item. High plant factor operation of high pressure, high temperature installations is not conducive to low maintenance costs. However, the greater the output, the lower the unit cost per kilowatt-hour. Boiler room and coal-handling maintenance costs account for about 60 per cent of the total maintenance costs for a coal-burning plant. The same costs for an oil-burning plant are somewhat less and for a gas-fired plant are still lower. The maintenance of the coal-handling and burning equipment explains most of the difference.

Production Costs—Fuel

Fuel costs amount to 50 to 80 per cent of total production costs. Fig. 2, covering operation and maintenance costs, exclusive of fuel, also shows the fuel costs for the Class A and B utility plants and for the most efficient plant. In utilizing present-day fuels, coal, oil or gas, there are only two ways in which such costs can be reduced per kilowatt-hour produced:

(1) A reduction in the cost of the fuel delivered at the point of use.

(2) By constructing more efficient plants which will require less fuel per kilowatt-hour generated.

Since plant thermal efficiency is covered elsewhere, the following relates only to the cost of fuel delivered at the plant and in the main to coal which accounts for approximately 65 per cent of the total thermal power produced per year. Historically, coal has been the principal fuel. Present indications are that, of the three fuels, it will continue as the principal fuel.

The cost of the coal, for all locations except those plants, few in number, located at the mines, includes transportation costs by rail, water or truck. In many instances the transportation costs are equal to or even greater than the cost of the coal at the mine. Therefore, despite the fact that the electric utilities are the biggest coal users, there is little that they can do to reduce fuel costs except by what can be done in constructing and operating plants as efficiently as possible with respect to fuel. Fuel savings for plants located in close proximity to the fuel source must be balanced against the costs of transmitting the energy to the load.

There are coastal locations where water-borne oil competes with coal and in the case of Florida the rail freight rates effectively bar the use of coal, leaving the market to oil delivered by water. In the Southwest and along the Gulf Coast from Mississippi westward natural gas is the principal fuel. Under prevailing conditions of the past several years coal and oil cannot compete with area-produced natural gas.

Figs. 3, 4 and 5 show for a period of years the cost of fuels delivered on a cents per million Btu basis to various

steam-electric plants. These charts, one for each of the three fuels, give the actual costs found under typical conditions in various parts of the country. Attention is called to the price fluctuations.

It would be most difficult to make any predictions as to the future cost of conventional fuels. In the future there will be, on a relative basis, less and less natural gas available for power generation. Coal will be our predominant fuel because of its abundance. Whether or not total mining costs can be reduced substantially is an unsolved problem. The future freight rates, where haul is involved, is a second unknown. There are minor considerations; for example, water-borne fuel on inland waterways can affect through competition the rail freight rates to a limited extent. However, in many cases rail haul is the only practical means of delivery. Pipe-line delivery of coal is under study. It may prove feasible in specific instances, i.e., short hauls. As yet no such pipeline has been built. A reversible belt carrier system has been suggested to carry coal one way and ore in the opposite direction. No further information is available on this unique carrier at this time.

Technological Progress

Just how have the costs of producing steam-electric power been kept at the low level of today? Some of the answers have been given above. The more intensive use of the plants brought on by the tremendous ever-growing power requirements of industry and the home have certainly contributed. The plant factors of today are more than double those of thirty years ago and the well-known incremental cost theory is very applicable to the power industry.

From the engineer's viewpoint there is a most important reason that can be pointed to with considerable pride. That is the technological progress that has over 50 years resulted in a continuing decline in the amount of fuel required to produce a kilowatt-hour. The trials and tribulations of those contributing to the efforts would fill many books.

Hence, it is appropriate to conclude with a summary of these technological advances expressed in terms of overall plant thermal efficiency[3] which in final analysis results in lower cost electric power.

Operation of the first 5000 kw turbine-generator unit in a plant of less than 25,000 kw total capacity, one of the largest plants at that time, began in 1903. With steam supplies at 200 psi gage pressure and 425 F total temperature, it required about six pounds of coal (75,000 Btu, more or less)[4] to produce one kilowatt-hour.

Today, 1955, the largest plant sizes range from 600,000 to about 1,000,000 kilowatts depending on the number of units installed with the larger individual units in the plants rated at 150,000 to 200,000 kw. There are now approximately 70 units totaling 11,500,000 kilowatts recently installed or under construction in 37 plants in this category. Still larger units are under consideration

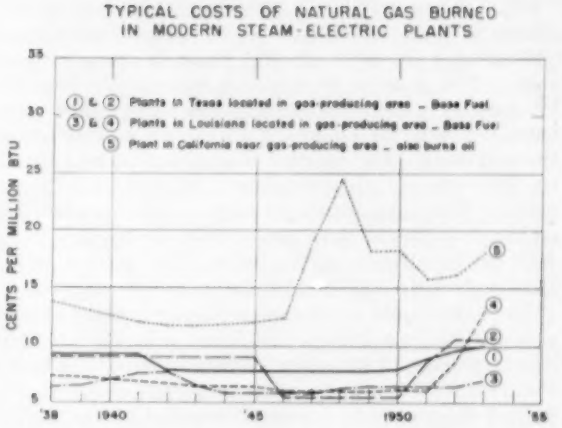


Fig. 5—Typical costs for natural gas burned in modern plants in cents per million Btu, delivered.

for the near future. The magnitude of the power loads, construction costs and operating economies, dictate the installation of the larger units. Typical steam conditions are 2000 psi and 1050 F total temperature with a single stage of reheat. Such plants, although few in number at this time, require about three-fourths of a pound of coal per kilowatt-hour or 9000 to 10,000 Btu per kw-hr. This fuel economy has not been accomplished in a single step but in many stages over a 50-year period of development. Space does not permit going into many of the significant steps in the development of the modern, efficient boiler and turbine of 1954.

Under actual construction at the Ohio Power Company's Philo station is a 125,000-kw experimental unit that will operate at 4500 psi and 1150 F with two stages of reheat. The expected results will be the production of one kilowatt-hour for about two-thirds of a pound of coal or 8500 Btu. The future optimum unit size for this design appears to be about 350,000 kilowatts and there is reasonable assurance that such units will be developed within a few years. The Philadelphia Electric Company has quite recently contracted for a 275,000 kw, 5000 psi, 1200 F installation that will use two stages of reheat at 1050 F. The expected heat rate is 8400 Btu per net kw-hr. It is expected that 1955 will see at least one more such unit on order. Hence, the most efficient coal-burning plants to be built within the next five years will probably operate at a heat rate of 8400 to 8500 Btu.

Since the heat equivalent of one kilowatt-hour is 3413 Btu, a half century of progress in steam power production can be summarized.

1903–1904	75,000 Btu per kilowatt-hour—4.5% Plant Thermal Efficiency.
1952–1953	9300 Btu per kilowatt-hour—36.7% Plant Thermal Efficiency.
1956–1958	(Estimated)—8500 Btu per kilowatt-hour —40.1% Plant Thermal Efficiency.

[3] The commonly used method of expressing steam-electric plant efficiency is on an overall thermal basis, i.e., the total amount of heat input expressed in British thermal units (Btu's) required to produce one kilowatt-hour. The heat equivalent of one kilowatt-hour is 3413 Btu. The most tangible results, efficiency and cost-wise, stem from the conversion of the heat units contained in the fuel to the mechanical energy required to rotate the electric generator. Therefore, we are primarily concerned with the steam generator (boiler) and the steam turbine and their several auxiliaries. Early in the development of the steamr tubine, as the successor to the steam engine, it was established that by raising the pressure and temperature of the steam required to operate the turbine, the efficiency of the plant steam cycle was improved.

[4] Bituminous coals used for boiler fuel in this country vary in heat value from slightly less than 10,000 Btu per pound to about 14,000 Btu per pound. In this report 12,500 Btu per pound has been used where it has been necessary to convert pounds of coal to Btu equivalents. Such estimates are required for the early years when engineers used the less exact pound unit. The Btu content basis is obviously more accurate. Electric utilities purchase fuel, coal, oil or gas, on the heat-unit basis, that is, the Btu content of a pound of coal, gallon of oil or per cubic foot of gas.

Fig. 6 shows, graphically, the progress in plant thermal efficiency from 1925 to date for the industry as a whole and also for the most efficient plant in operation each year. The pounds of coal required to produce one kilowatt-hour are given in the lower curve. The upper curve converts the pounds of coal to equivalent British thermal units. The middle curve shows the heat rate of the most efficient plant reported each year for a 25-year period. For comparative purposes a point is established on the 1955 line to show the estimated efficiency of the 4500 psi installation at the Philo, Ohio, station and in 1957 to show the 5000 psi installation at Philadelphia.

The actual gain in thermal efficiency, during the 50-year period from 1903 to 1953, is about 700 per cent. The expected gain from developments now in sight is only about 10 per cent. It therefore seems probable that only limited improvement can be anticipated in the thermal efficiency of conventional steam plants.

The progressive development of steel and steel alloys to withstand the ever-increasing steam temperatures and pressures has made possible better thermal efficiencies of steam-electric plants. Still better efficiencies are contingent on further developments in alloyed metals.

The above discussion shows the remarkable progress made in going from the Cast Iron Age through the Cast Steel and Alloy-steel Ages, from 1903 to 1954, to the new and coming age of Super Alloy Steel. The gain expected in going from the Alloy to the Super Alloy Age is small but from the viewpoint of power production economics it is particularly significant in the application of higher pressures and higher temperatures.

Some of the more significant features or improvements that have been made in steam production and utilization during the 50-year period are listed below.

Superheated steam—Steam from the boiler is raised above its saturation temperature on its way to the steam-turbine. This permits greater expansion of the steam before the moisture entrained becomes objectionable from the standpoint of erosion of the turbine blades. Greatly improved thermal efficiency of the steam cycle and some reduction of costs result.

Surface condenser—The surface-type condenser, with its necessary air-removal equipment, permits the retention for re-use of the condensed steam after its passage through the turbine. This reduces the amount of water that must be added to the steam cycle to a nearly negligible quantity. The result is greatly reduced cost of makeup water and treatment, and, hence, reduced operating expenses.

Regenerative feedwater cycle—Partially expanded steam is extracted from one or more points along its path through the turbine and is used to heat the feedwater to a temperature approaching that of the water in the boiler. This results in improved thermal efficiency of the steam cycle, and, consequently, reduces the amount of fuel required to generate a kilowatt-hour.

Economizer—The economizer utilizes heat in the flue-gas that would otherwise be wasted to heat the feedwater to the saturation temperature of the water in the boiler. Better thermal efficiency for the plant results.

Air heater—The air heater transfers heat from the flue-gas as it leaves the economizer to the combustion air entering the furnace, with resultant fuel savings.

Forced and induced draft fans—These fans overcome the resistance offered by the economizer, air heater and superheater to the flow of flue-gas as it leaves the furnace and, in addition, contribute to more complete control of fuel combustion, thus reducing fuel consumption.

Waterwall furnaces—The use of water tubes, properly spaced, as part of the furnace walls increases the rate of efficiency of heat transfer within

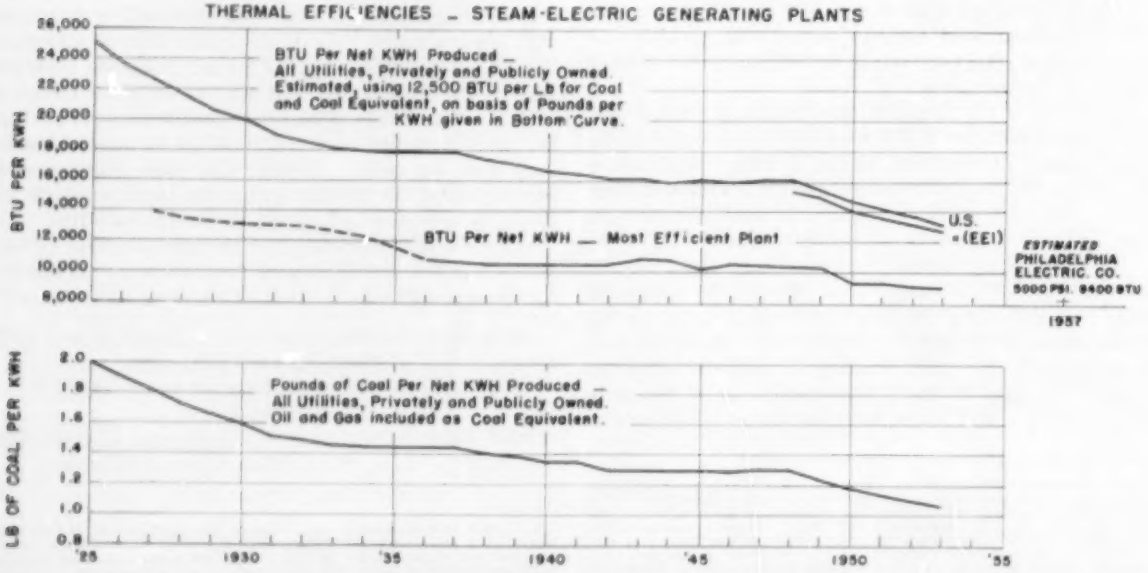


Fig. 6—Progress in plant thermal efficiency from 1925 to date for the industry as a whole and the most efficient plant in operation each year shows in the above set of curves. The pounds of coal to produce one kwhr is the lower curve

the furnace. This increases the boiler efficiency and decreases the size and capital cost of the furnace.

Pulverized coal firing—The firing of coal as a fine powder (about the consistency of face powder) gives quick and complete combustion of the fuel with resultant heat transfer characteristics superior to those associated with other methods of coal firing. In addition to improving boiler efficiency, this method results in smaller boiler volume and consequent lower capital costs for plant. Ash disposal is simplified and reflected in lower operating costs.

Reheat—The return of steam at an intermediate pressure (after it has been partially expanded through one section of the turbine) to a low-pressure section of the boiler where its temperature is raised to approximately the original throttle temperature before it expands through the remaining turbine sections results in a significant improvement in the plant's thermal efficiency.

Automatic combustion control—The automatic mechanical and electrical devices used to control combustion, as the load varies, do a better job than the human operator. The result is better thermal efficiency and lower labor costs in the boiler room.

It is most illogical to infer that the advances have been confined to the boiler and the turbine and their several auxiliaries. Quite to the contrary. There is always an efficient generator of adequate size to match up with the turbine. The progress in the design, construction and operation of the shaft-connected generator with its auxiliaries, switchgear, and so forth, is equally remarkable. Present day applied knowledge includes improved magnetic materials, better insulation, the use of hydrogen and liquid cooling, and hollow conductors to remove heat, higher generator voltages and many other important improvements over the early day generator. Standardization of turbine-generator design on a wide scale in recent years has been an outstanding contribution to reduced investment and operating costs.

As of now the turbine and the generator are not faced with possible direct competition. The steam boiler is confronted with such competition.

In conclusion this can be said—any significant developments and improved technique will result in savings in the total cost of delivering steam-electric power to the system and consequently in savings to the ultimate consumer.

Gas Turbines Promise Heat Recovery Benefits

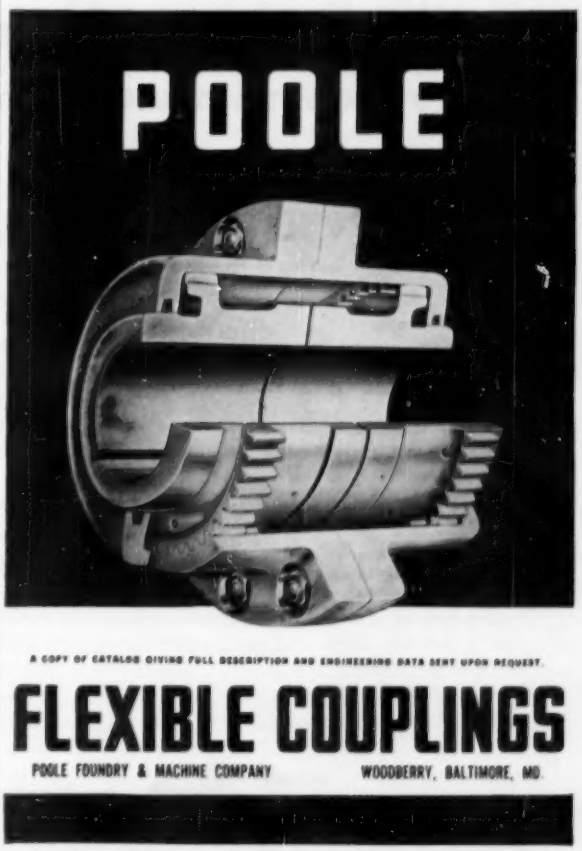
High temperature gas turbines offer a promising method for utilizing the heat produced in atomic furnaces, in the opinion of Farrington Daniels, professor of chemistry at the University of Wisconsin, expressed before the engineers attending the recent seventh annual Engineers Day celebration on the Wisconsin campus.

Such turbines must be operated at high temperature to be efficient, and Mr. Daniels declaimed, the nuclear reactors used with them would have to be constructed of ceramic materials rather than metals because of the intense heat.

This is highly desirable since the energy available in the world's uranium and thorium probably exceeds that available in all our coal and petroleum, he added. The extent of the reserves depends greatly on the chemists' ability to recover uranium economically from low-grade ores. This uranium eventually will be exhausted, however, and then it will be necessary to trap the energy of sunlight for power. There is an ample supply of solar heat for all needs if scientists can only find an economical way of using it, according to this speaker. Incidentally the Rockefeller Foundation recently gave the University of Wisconsin a research grant of a quarter of a million dollars to explore methods to utilize solar energy.

On this general subject Mr. Daniels expressed the conviction that there is a real need for developing an inexpensive engine operated by solar energy. It would find immediate use for pumping and irrigation in arid regions. The biggest problem facing scientists is designing sunlight collectors which are inexpensive. At the moment plastics afford hope that this can be done. A semi-parabolic balloon with a thin, aluminized plastic on the parabolic surface could be developed, and experiments conducted by Dr. John A. Duffie of the University of Wisconsin's Engineering Experiment Station indicate that this may be a practical approach, in Mr. Daniels' opinion.

From quite another quarter comes the report that the General Electric Company will manufacture two 16,000-kilowatt combustion gas turbine-generator sets for a Mexican industrial firm, the Planta Electrica de Groupo Industrial in Monterrey. These sets will have a higher rating than any yet made in the Western Hemisphere.


POOLE
A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.
FLEXIBLE COUPLINGS
POOLE FOUNDRY & MACHINE COMPANY
WOODBERRY, BALTIMORE, MD.

See "your" Buell Dust Collection System in action before you buy it!

BUELL ENGINEERS have installed dust collection systems from Pennsylvania to Peru. They will gladly give you the names of nearest users so you can see for yourself the efficiency of Buell equipment . . . get vital information from their operating and maintenance records!

BUELL ENGINEERS, drawing from their complete line, will recommend the unit, or combination of units, best suited to your needs. They'll give you complete design and performance data about the Buell "SF" Electric Precipitator with its unique "Spiralectrode" and continuous cycle rapping . . . Buell Cyclone Collectors with exclusive "shave-off" design . . . other proved-in-use Buell achievements!

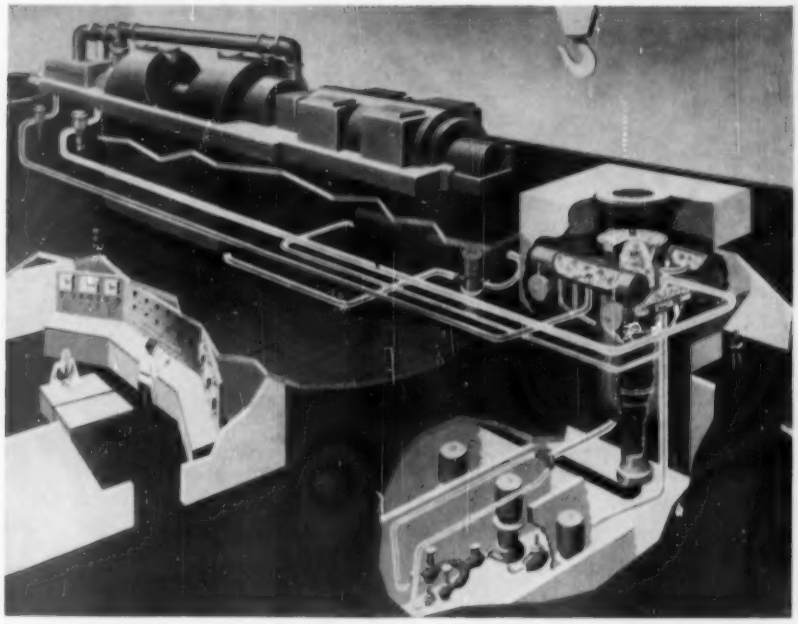
BUELL ENGINEERS will submit samples of your dust to their laboratories for analysis . . . make an on-the-spot check of your operating conditions. They will then tell you exactly what percentage of stack discharge will be collected by Buell equipment. The records show that their predictions have been amazingly accurate!

For More Facts . . . write for booklet: The Collection and Recovery of Industrial Dusts, which explains *all three* Buell Systems. Dept. F-70, Buell Engineering Company, 70 Pine Street, N. Y. 5, N. Y.

buell®

MECHANICAL ELECTRICAL

20 Years of Engineered Efficiency in **DUST COLLECTION SYSTEMS**



Perspective of nuclear central station employing dual-cycle boiling reactor

The Dual-Cycle Boiling Reactor*

Recent announcement by the Nuclear Power Group, Inc., to build, subject to AEC approval, a 180,000-kw nuclear generating station makes this article especially timely. Thermal energy for the station, according to the proposal, is to be supplied from a General Electric dual-cycle boiling reactor to be located on a 750-acre site in Grundy County, Illinois, and operated by the Commonwealth Edison Co. This type reactor is expected to retain the inherent safety of the direct-boiling reactor and can be constructed in much larger sizes for central station use.

IN MOST nuclear reactor systems, heat is removed by a circulating liquid such as water. Such plants usually have a heat exchanger for steam generation located between the reactor and the turbine. The first water-cooled reactors have used hot water under pressure to remove heat from the nuclear fuel. In such reactors, this cooling water is pumped through a heat exchanger where its heat is used to boil water under lower pressure. Steam from the heat exchanger is then used to operate the turbine.

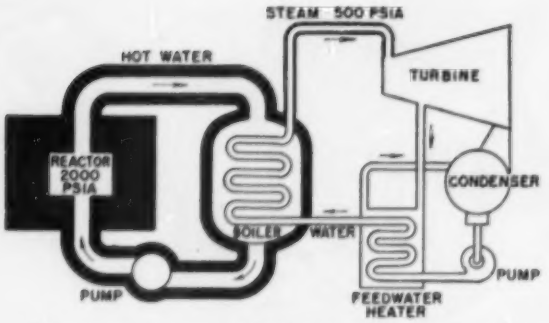
High-temperature water is an excellent heat-transfer medium, permitting the removal of large quantities of power from comparatively small reactors. For this reason, liquid-water-cooled reactors have found application where high power output is required from a small plant, such as in naval propulsion applications. However, other features of the design are not attractive for some applications. In order to suppress boiling, high pressure in the reactor is used. This factor, coupled with the temperature loss in the heat exchanger, results in the use of a reactor pressure three to five times higher than the steam throttle pressure. To accomplish this thick-walled pressure vessels and piping are needed.

Simple Boiling Reactor

Following intensive study of the main disadvantages of the liquid-water-cooled reactor, the Argonne National Laboratory developed a new concept. This was to generate the turbine steam directly in the core of the reactor, instead of in a separate heat exchanger. This is the idea of a simple boiling reactor where heat produced in the fuel rods is used to generate steam within the reactor itself. This steam is then used directly in the turbine. A 5000-kw electric plant of this type is under development at the Argonne Laboratory as part of the AEC five-year program.

* This article is based on notes obtained at several recent technical meetings and upon a General Electric Co. news release dated May 14. On April 1 at the American Power Conference in Chicago, S. Untermyer and A. G. Mellor of G-E's Atomic Power Division described the dual-cycle reactor and analyzed the economics of its application. On April 4–5 in San Francisco Mr. Untermyer made a comparable presentation at the conference on atomic energy sponsored jointly by the Atomic Industrial Forum and Stanford Research Institute. In New York on April 14 the dual-cycle reactor was described before the ASME Metropolitan Section by G. M. Roy of General Electric Co.

Complete copies of the papers on the G-E dual-cycle boiling reactor as presented at the San Francisco conference in April may be obtained in the Proceedings of this meeting from the Atomic Industrial Forum, Inc., 260 Madison Avenue, New York 16, N. Y., for $5.



Schematic diagram of high-pressure water reactor

A heat exchanger is not required by this simple system. The pressures and temperatures in the reactor are much lower. Actually the pressure in the reactor need be little greater than the turbine throttle pressure. For a given coolant temperature in the reactor, the thermal efficiency of this system is much higher than that of the system using hot water and a heat exchanger. For a reactor temperature of say 500 F, the gain in efficiency is 16 per cent.

Tests have also shown that the boiling reactor system provides an unusual degree of inherent safety. In event of a reactivity excursion, a boiling reactor core fills with steam. Since the neutron moderation of the water is required to sustain the chain reaction, the reactor, in effect, quenches itself. Thus, boiling reactors are safe reactors.

On the other hand, there are definite limits to the power output per unit volume of a direct boiling reactor. As the water boils, its density fluctuates, and any density change will affect the moderation of neutrons. In consequence, the power level will fluctuate unless the maximum steam void fraction is limited to that which smooth operation can achieve. It is probably not feasible to control more than a few per cent reactivity with steam voids. In a simple boiling reactor, this practical limit may correspond to some 20 per cent of steam voids, averaged through the reactor core.

For a small reactor where the length of steam travel through the core might be as low as two feet, a reasonable power density per unit volume can be achieved, without exceeding 20 per cent steam void fraction. Where the steam path is lengthened to eight to ten feet, as in large reactors, the power density that can be produced from a simple boiling reactor is reduced so low that unreasonable reactor sizes result.

Another difficulty may arise from the behavior of a boiling reactor during a change in load demand. A sudden increase in load demand will increase the steam flow from the reactor, causing a reduction in pressure, which will result in flashing water into steam with the reactor. This steam will serve to reduce the reactivity, and hence the reactor output will tend to fall just when more power is needed. Thus the simple boiling reactor is not self-regulating with regard to changes in load and reactor control adjustments are required to match load variations.

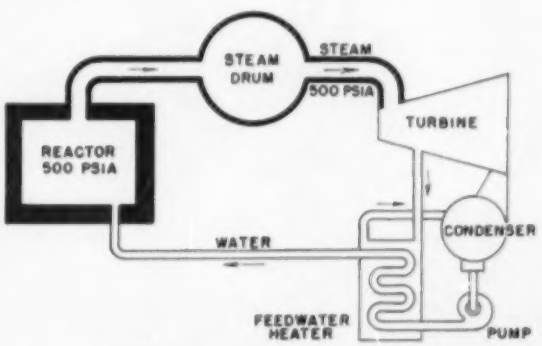
Dual-Cycle Boiling Reactor

The challenging problem was to find a reactor system which preserved as much of the boiling reactor's unique assets as possible, yet avoided its disadvantages. In the General Electric Dual-Cycle Boiling Reactor subcooled water is obtained from a flash tank system, operating in conjunction with the boiling cycle. For this illustration 600 psia has been selected as the operating pressure within the reactor vessel. The flash system operates to produce 350-psia steam, which is admitted to an intermediate stage in the turbine. In the flash system, water from the reactor passes through the flash vessels where pressure is reduced, thereby causing a fraction of the water entering the flash tank to be converted into steam, while the remainder is cooled. This water is then pumped back into the reactor, to provide the subcooling required.

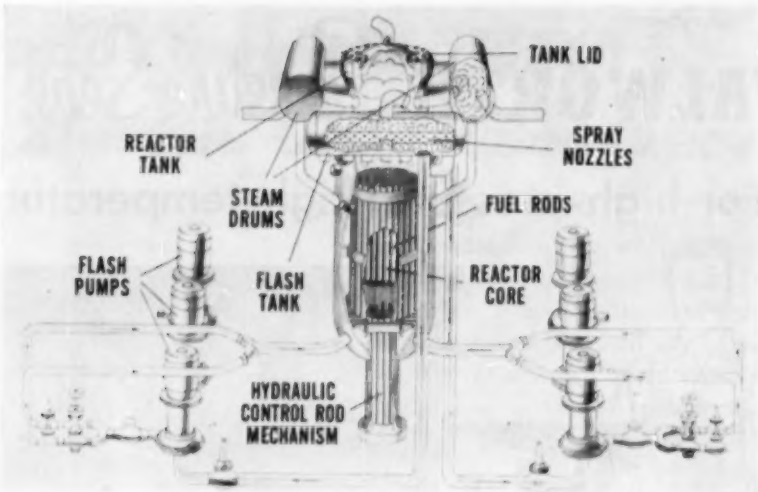
This dual cycle succeeds in overcoming the two main limitations of the simple boiling reactor, low power output for a given size and poor stability under load variation. It preserves a large amount of natural circulation and much of the equipment simplicity of the basic boiling cycle. There is some compromise of the thermal efficiency gains theoretically obtainable in the simple boiling reactor, although this cycle maintains a thermal efficiency advantage over liquid water cooled reactors. The major safety advantages associated with boiling are just as effective in the dual cycle as in the simple boiling reactor.

Self-Stabilizing Features

The really important feature of self-stabilizing reactor power with load variations is attained in the following way: Most of the turbine governor adjustment for load variations takes place in the 350-psia admission. Consequently, the sub-cooling in the reactor increases with load. When there is a demand for more power, the turbine governor acts to admit more steam from the flash tank, while the flow of steam into the 600-psia high-pressure stage is not immediately affected. As the steam demand from the flash tank increases, the pressure in the tank drops, so that more water flows into the tank. The flash pump draws off more water from this tank to hold a constant level, and the amount of sub-cooled water entering the reactor increases. Consequently, the number of steam bubbles within the core is reduced, and the reactor output rises to meet the load demand. It is to be noted that this stability during load changes is obtained without sacrifice of the inherent safety characteristics of boiling reactors. When reactivity is suddenly added to this reactor, there is a large increase in steam voids, which tends to shut the reactor down.



Schematic diagram of simple boiling reactor



Cutaway arrangement of dual-cycle boiling reactor

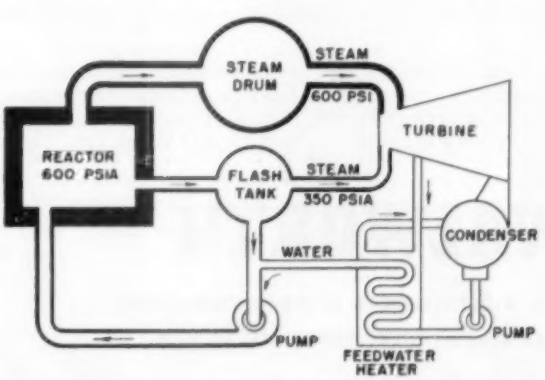
In the dual-cycle boiling reactor, the core consists of a vertical array of slightly enriched uranium rods. The fuel rods are supported in hexagonal zirconium coolant channels, arranged in a "honeycomb" pattern. These coolant channels extend above the reactor core, to form "chimneys" which are used to promote natural circulation of the steam-water mixture.

Control of the reactor is by vertical rods, actuated by hydraulic pistons. There are enough rods so that it is possible to move an individual rod quite freely without seriously affecting the reactor.

Reactor Core

The chain-reacting core is contained in a pressure vessel. The pressure tight lid provides ample access for repairs to the reactor, or for replacement of fuel. This lid is sealed so that internal pressure in the tank tends to seat this closure during operation. The reactor tank is filled with water during fuel reloading or repair work. This thickness of water provides a biological shielding against the radiation from the spent fuel which is important during fuel reloading operations.

The upper part of the tank serves as a steam dome, to dampen pressure variations in the reactor, so that rapid power fluctuations do not materially affect the reactor voids. The steam dome volume is also used as region where the steam velocity is reduced, so that the bulk of the entrained moisture precipitates.



Schematic diagram of G-E dual-cycle boiling reactor

The water returns to the reactor under the influence of natural circulation, passing down the outer portion of the reactor tank, around the reactor core. This water mixes with the water from the feed and flash system, and the combined flow enters the bottom of the reactor core.

The two 350-psia flash tanks are mounted upon the same cylindrical supporting structure that holds the reactor pressure vessel. This arrangement makes it possible to use the flash tanks as the supports for the 600-psia steam drum. With this arrangement, operating temperature differentials throughout the drums and piping system do not introduce appreciable thermal stresses in the piping.

The simplicity and small size of this reactor plant compared to conventional fueled boilers gives a visual indication of the future potential for cost reduction and for vigorous competition with conventional steam plants.

Summary of Features

The principal features of the dual-cycle reactor may be summarized as follows:

1. Primary loop pressure essentially the same as turbine pressure.
2. Good thermal efficiency for a given reactor temperature.
3. Exceptionally high degree of inherent safety due to boiling in the reactor.
4. Flexibility of operation to meet power demand changes without delay.
5. Self-stabilizing power level to match load variations.

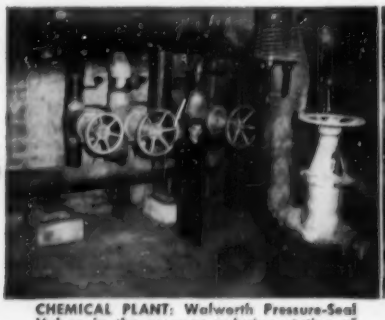
It is estimated that the installed cost of the dual-cycle boiling reactor central station will range from $200 to $270 per net kw of output, excluding site costs. Comparative operation and maintenance costs for a nuclear power plant and a conventional station are respectively $5.60 per kw per year and $3.50 per kw per year.

In summarizing one of the papers G-E engineers emphasized that nuclear power generation *will not* make conventional steam stations obsolete and that there will be a large market for this type of power equipment for many years to come. They urged that, along with the developments of nuclear central stations, research and progress be continued to insure optimum efficiency in all power generating facilities.

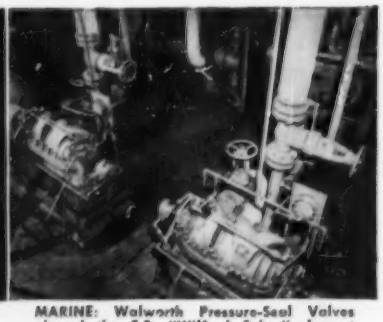
WALWORTH *Pressure-Seal* VALVES

For high-pressure, high-temperature services

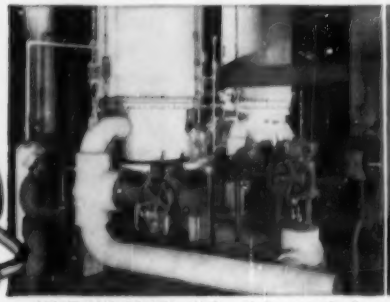
Walworth 6-inch Series 900 Pressure-Seal Gate Valve with Series 1500 Y-type Globe Valve on the by-pass.



CHEMICAL PLANT: Walworth Pressure-Seal Valves in the pressure reducing station of a chemical plant.



MARINE: Walworth Pressure-Seal Valves aboard the S.S. "Wilfred Sykes"—largest Great Lakes ore carrier.



LIGHT AND POWER: Walworth Pressure-Seal Valves equipped with motor operators, in an eastern public utility plant.

PAPER MILL: Fabricated header with 8-inch Series 600 Pressure-Seal Y-Globe Non-Return Valves and Series 600 Pressure-Seal Gate Valve.

SMALL VALVES FOR HIGH PRESSURE-TEMPERATURE SERVICE

Series 1500 Cast Steel Y-type Globe and Angle Valves in sizes ¼ to 2 inches.

The bonnet and body design of Walworth Pressure-Seal Valves is such that the pressure within the valve is used to prevent leakage at the junction of the bonnet and body. The bonnet joint of the Walworth Pressure-Seal Valve is permanently tight because there is no dependency on the ability of any component part of the joint to resist creep during long exposure to high temperature. Sudden temperature and pressure changes do not affect this tightness. Bonnet flanges and studs are eliminated and the weight of the valve is reduced.

An improved flexible disc design maintains seat tightness, even when the valve body is distorted by pipeline stresses or by temperature and pressure changes. This improved disc design makes it easier to open and close this valve.

Walworth Pressure-Seal Valves are easy to disassemble and assemble, and are the most satisfactory valves for high-pressure, high-temperature service. They are available in Series 600, 900, 1500, 2500 and in a wide range of sizes and types. For further information, write for Circular 116.

WALWORTH

valves • fittings • pipe wrenches

60 EAST 42nd STREET, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

Problems and Opportunities in Electric Utility Engineering*

By PHILIP SPORN

President

American Gas, & Electric Company

The problem of recruiting youth to power engineering, touched upon briefly in the May 1955, COMBUSTION editorial, has been a prime concern of the AIEE at its recent meetings. Here one of the foremost men in the electric utility field presents a most effective description of his industry and the possibilities it holds forth for young engineers.

THERE is a generally prevailing notion, particularly prevalent among engineering students and young engineers just embarking on their careers, that electric utility engineering is of no great significance; or if it is, that it offers very little excitement or opportunity to a serious, able, and ambitious young engineer for productive work and for growth and development. By utility engineering I mean engineering as carried out by the many electric utility organizations. While some of these are very large, a great many are much smaller; and yet their lack of size does not give them any exemption from having to contend with the many problems or a good many of the problems, that the larger organizations have to deal with.

Utility Engineering Underestimated

The general line of reasoning behind this putative state of affairs in utility engineering is a four-forked one. First, there is the altogether too common notion that there are no real problems of any size, complexity, or significance in utility engineering. Indicative of that state of mind is the publicly expressed opinion some years ago by one nationally very prominent engineer and government administrator that electric utility systems are fundamentally much simpler than a shoe business. Again, it is frequently stated that, if any problems do exist, they were all solved a long time ago, so that all there is to do today is to go to a book or a report shelf and take down the solution just as one would take down a package of carriage bolts. If this does not satisfy an insistent or persistent inquirer, he is informed that, "Well, all new engineering, if any has to be done, is done by the electrical and mechanical and other manufacturers anyhow." Thus, obviously, no engineering remains to be performed by any members of a utiilty engineering organization. Finally, if this last argument doesn't stand up, one is always confronted with the statement, "You'll have to admit whatever utility engineering there is to be done is much too prosaic: certainly there is no excitement in doing it." In other words, it has, to use a much-abused phrase, no "glamour."

This is so formidable a line of argument that it would be particularly impressive if the facts were available to make it good. Unfortunately, or perhaps fortunately, the facts aren't so at all and the argument, therefore, ingenious as it is simply falls down for lack of any solid factual basis of support.

The Economic Significance of the Industry

One of the reasons, perhaps, why such bad thinking is being done on the utility engineering problem is the failure to appreciate the economic significance of the operation of the electric utility systems of the country. It isn't so long ago that the steam railroads were *the* basic industry of the United States. Yet, with a much later and much slower start, the electric utilities of the country pulled up to the railroads in plant investment in 1952 when the figures for both reached an approximate value of $25 billion. Since then, electric utility investment has pulled far ahead of the railroads.

Even more significant in this connection is an examination of the investment of the electric power industry relative to some of the other basic industries, a number of them being, admittedly, in the more "glamorous" category. When you compare the investment figures in these for the year 1953, for example, against the investment in the power industry you find:

Chemical and allied products	Less than 60%
Aircraft	About 11.5%
Electronics	About 13.5%

If you examine the electric power industry investment for 1953 and compare it with that in all manufacturing corporations' facilities over all of the United States, you will find the electric power investment close to 15 per cent of the total. Even more striking is this: the total investment expenditures made in 1952 in electric power facilities were about 22.5 per cent of the total investment expenditures in plants and equipment of all manufacturing corporations in the United States, and in 1953 the figure rose to 23.5 per cent.

If anything further were needed in the way of statistics to bring out sharply the great and deep economic significance of the electric utilities to the economy of the

* Paper delivered before the AIEE Middle District Meeting, Columbus Ohio, May 4, 1955.

United States it is this: at the end of 1954, after approximately 75 years of growth and development of the electric utility industry, total investment in their facilities reached a figure close to $30 billion. Competent and serious students of the indicated developments that are ahead in the field of power, all more or less agree that there is good reason for the conclusion that some time within the next 20 to 25 years the utility systems' facilities will have to be approximately quadrupled, and the investment will go up in about the same ratio.

If you start from an investment base of $30 billion it is obvious that in this period it will be necessary to bring about a net additional investment of some $90 billion; the gross investment will obviously be considerably greater.

It would thus appear from the above that the question of economic significance of the electric utility industry today cannot be a matter of argument, and that there is perhaps very good reason for the belief that as time goes on the industry may become the most important single industry in the United States. It will command such a position not so much on the basis, perhaps, of value of annual product, but particularly on the score of capital investment, and on the basis of the fundamental pervasive character of electric power and the complete involvement that electric power is going to have, to a much greater extent in the future than even today, in every phase of activity and living in the United States.

What Electric Utility Engineering Is

What is utility systems engineering and how does it differ from the engineering carried out by the manufacturers? It is quite clear that the manufacturers' responsibility is to design and build equipment or parts of equipment utilized in building utility systems. Utilities engineering is concerned with planning, building, operating and maintaining the utility systems which are, in turn, composed of numerous components: many of them built by manufacturers, but a great many others put together by the utilities themselves out of essential raw materials, like steel, concrete, pipe, conductor, etc. There is, however, this limitation: that whereas the manufacturers frequently do the conceiving and the designing, and almost always do the building of the equipment, they are in no position to know what to plan to build, or what to plan to develop, until the utilities system engineers have done their part and have indicated what it is that they will need or want. The latter is the function of the utility engineer. The proper carrying out of that function by the utility engineer involves study and planning of his power system. And that involves a constant study and understanding of short and long-term political and economical developments both national and international; study of population growth and population shifts; study and understanding of social, economic, and ecologic factors of varies areas; thorough knowledge of the industries basic to each area or region served and of the possibilities of promoting growth and development of the existent industries and of the establishment of new industries.

Indispensable to the planning of any power system is a basic study of fuel supply: white coal, fossil fuels, and, almost in the offing, nuclear fuels—their availability, their transportation, and their purchase on short- and long-term arrangements.

Opportunities in Utilities Engineering

The study and planning of the system proper starts with the power plant and carries on through the transmission system, gets down to the distribution facilities, and ends up with the utilization system. This is a big deal.

In the study and development of generation itself, what fuel resources to employ? How and where to build power plants? What size plants to build? What size units to build? What kind of thermo-dynamic cycle to employ, and more particularly what temperature, pressure, superheat, reheat to use? What voltage to employ as a generating voltage? How to give physical embodiment of the plant? What basic plan of construction? How excavate? How found? How control river rise and fall and abnormal rise? To properly answer all of these questions involves almost all phases of engineering, and calls for the solution of many problems of great difficulty and complexity.

Similarly there are many difficult engineering problems in transmission: The planning of the transmission system itself—how and where to build the lines? What voltage to employ? What form to give structures, whether single or double, or multi-circuit type; how to tie transmission systems into subtransmission and distribution systems? How to most effectively utilize each to its economic limit? All of these individually and—even more so—collectively, are difficult problems.

The problems encountered in utilization and in distribution are not less numerous, bothersome and important. In utilization—in the field of electric energy as in no other item of economic use—consumption has to take place before manufacture, and consumption can only take place through the utilization medium. Thus, the utilization medium and the associated system of wiring are indispensable elements in any kind of electric power operation. In the distribution field, this is significant: that of all the elements involved in the basic power supply chain outside of utilization—that is, generation, transmission, and distribution—distribution is by far the most expensive of the three and takes the largest investment of the three. Here, therefore, are the greatest opportunities and perhaps the greatest difficulties. And the field is almost entirely the utility engineer's.

Thus, whether examined from the standpoint of economic significance or economic value or from the standpoint of the allocation of problems between the manufacturing and the utility system engineering organization, there would seem to be no question that opportunities of every kind and variety and of unlimited scope are available to the engineer, if the qualified judgment of the extent of growth and development that lies ahead for the electric utilities is accepted.

Economic Index of Opportunities Available

Perhaps no other simple arithmetical example as the following will bring home the importance of, and opportunities in, engineering and in development of economic usefulness of new engineering ideas in the field of electric power supply than the following. A number—perhaps more than a half dozen—electric utility systems are today approaching the point of annual output of close to 20 billion kwhr, and the prospect of these values growing not to four times the present values, but to a more mod-

erate figure of two and one-half times is extremely bright and in a relatively short period—something of the order of 12 to 15 years. With a system having an output of 50 billion kwhr per year, a saving in generation, that is, an improvement in efficiency of heat conversion, of only 100 Btu per kwhr represents an annual value of $1 million with fuel at 20 cents per million Btu and $1.5 million with fuel at 30 cents per million Btu. In this same kind of system, a saving in costs other than fuel of only 0.01 mill per kwhr represents an annual value of $500,000 and a saving of 0.1 mill per kwhr represents the staggering annual value of $5 million. Certainly, where economic prizes of that sort are available the attractiveness of the effort to bring about such an economic gain would appear to be almost irresistible.

Some Specific Examples of Opportunities

It must be admitted that some of the discussions given above are perhaps on the general side, and it may very well be that there is reason for skepticism as to whether solid and substantial opportunities exist in the field of utility engineering, when the problem is restated on a more specific basis. There is some point, therefore, in an effort to expand the discussion of the problems on a more specific plane. If one attempts to do that, one of the first things one is confronted with is an assumption as to the kind of electric power system one visualizes for the future.

In the discussions given earlier I alluded to the informed judgment that a quadrupling of present capacities and, therefore, electric energy generated and distributed over or within the relatively short internal of 20 to 25 years is a reasonable expectation. A discussion of specific problems to be encountered can, therefore, best be carried out against a background of 2000 billion kwhr as the annual utility production some 25 years hence. Just fixing that point makes possible a reasonably realistic examination of the many elements of the power supply problem that will confront the planners and builders of the power system in the United States and the engineers of the electric utility systems. And this begins to show not only what is already known, but perhaps what is lacking and, therefore, where the opportunity lies—by research, by inventiveness, to solve and thus help bring into being these very much larger power systems of the future.

When the power systems of the future are examined against this background, one of the first conclusions that one is forced to is that fundamentally the American power systems of that time will, to a large extent, continue to be powered by conventional or fossil fuel burning stations. Furthermore, there is today every indication that coal will have to carry an increasingly greater share of the burden as the availability of gas and oil decline. The problems of mining and transporting the tremendous quantity of coal which will be required for electric generation alone—a figure which 25 years from now will be perhaps 25 per cent greater than the entire output of coal in the United States in 1954—certainly will require a great deal of thought and effort to solve: underground gasification and increased mechanization in the mines are but two avenues of approach. But of particular importance to electric utility engineers will be the problems created by wastes which may be released to the atmosphere as a result of burning large amounts of coal in concentrated areas. This problem itself has two aspects: meteorological, relating to dispersion of the gases and fine particulate products of combustion; and chemical, relating to the toxicity of the wastes themselves.

Place of Atomic Power

Now, what about atomic power? Although it will be some time before nuclear fuel will be economically competitive with coal as a primary energy source—and this is particularly true since a nuclear technology cannot be built up overnight, while progress in conventional means of electric energy production will continue—we must think in terms of the efforts needed to bring about competitive atomic power in the future. Although, as I have pointed out, coal will still be the principal energy source of the electric power systems of the quarter century ahead, atomic power will nevertheless play a rôle in the production of the 2000 billion kwhr we have visualized, but not until a lot of problems have first been solved. There are today electric utility engineers actively engaged in research directed towards their solution and these efforts will have to be maintained and expanded. There is, for example, the Shippingport project where the heat to power a 60,000-kw steam turbine-generator will be developed from an atomic reactor. We will learn much from this and other installations in the future through building and operating them. But the problems to be solved are numerous and difficult. There is the problem of radioactive waste disposal; there are the problems of reactor technology and materials; and there are many problems created by the inherently hazardous nature of a nuclear reactor. All these are challenging and will require basic research in many fields. Since the utility engineer will be responsible for the final product, he cannot avoid his share of participation in working out the solutions.

Efficiency Trend

The established trend of the efficiency of converting primary fuels into electricity has been upward for many years. Steam pressures have been increased from the 2300–2600 psi of today's new equipment, with an accompanying increase in thermal efficiency so that in 1954 the most efficient steam-electric station had a heat rate of 9100 Btu per kwhr. It has been evident, however, for some time that, if further gain was to be brought about economically, it would have to be brought about by a bold step forward. Such a step has been taken and there is well along in construction today on the American Gas and Electric Company System a supercritical pressure turbine-generator which will operate at 4500 psi and whose thermal efficiency will be 40 per cent. In further prospect there are pressures as high as 15,000 psi which will be accompanied by higher temperatures and higher efficiencies. But this region is today an unknown one, as regards the properties of water and other materials. Not only will research and development have to be carried out to extend our knowledge of the behavior of water and steam but also the properties of the materials that will go into the boilers and turbines will have to be studied, new alloys will have to be developed and tested.

And in this work, too, the utility engineer will have to play a leading part.

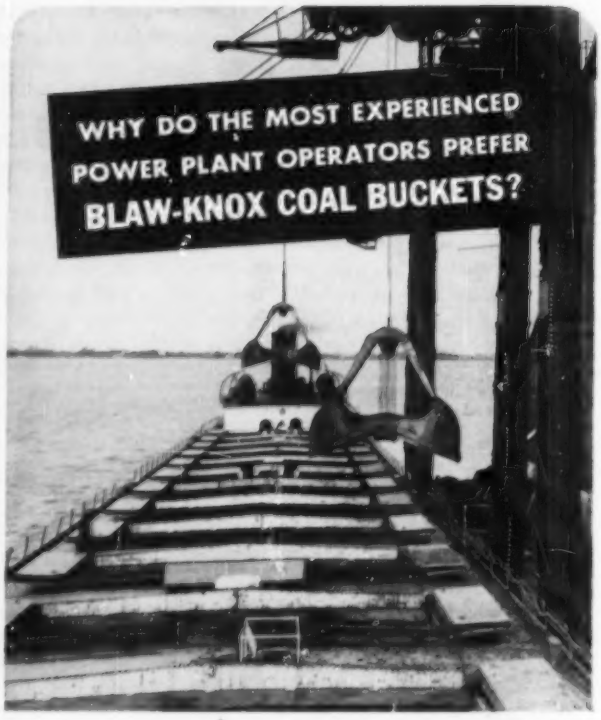
High Voltage Transmission

In the field of transmission of electric energy a great deal of progress has been made in recent years toward the development of higher voltage systems. Increased power system loads, increased size of generating units, concentration of generating capacity and, very importantly, a need to develop transmission capacity as economically as possible have all been factors in the decision to take the step to higher voltages. On the American Gas and Electric Company System there is in operation today the substantial beginnings of a 330,000-volt transmission system which will, when completed, serve as the backbone transmission for a power system with a peak of 15 million kw and an annual system input of over 90×10^9 kwhr. That this and perhaps still higher voltages will have to be extensively utilized in the 2000 billion kwhr per year systems of 25 years hence is almost axiomatic: one need only ponder on the relatively mere 471 billion kwhr produced by utility systems in the United States last year to realize its inevitability. A great deal of work has been done in developing the technology of this ultra high voltage transmission, but a great deal more remains to be done. Particularly rewarding will be a more extensive knowledge of the fundamental nature of the corona and ionization phenomena which accompany the use of very high voltages.

Energy Utilization

Finally, the field of energy utilization presents many fascinating and challenging problems. An outstanding example is one encountered in the development of electric house heating and conditioning; it seems certain that eventually all heating and conditioning will be done by electricity alone or in combination with solar energy. The devising of an economical and efficient means of heat storage will be a great step forward in bringing about this development. The incentives for this are numerous. Perhaps the most exciting is the one that can easily be derived from a consideration of the conservation of our primary fuels. If we assume that 67 per cent of the energy in fuel is converted to heat when burned directly for heating, then it is simple arithmetic to show that a heat pump with a Coefficient of Performance of $3^1/_2$, when supplied from an electric power system whose thermal efficiency of generation is 40 per cent and whose transmission and distribution efficiency is 80 per cent, will result in a saving in original fuel of over 40 per cent. Obviously the rewards of such an accomplishment are of great significance to the entire economy. But here, too, the utility engineer has an indispensable part to play.

Accomplishments of the past, and the developments of the future—of which those just mentioned are but a few—did not and will not just come about: They have been and will be the result of continuing thought, basic research, sound, forward-looking engineering, and a great deal of effort. When consideration is given to the basic and ubiquitous rôle of electricity in our economy, one cannot fail to realize the importance and challenge of the problems ahead in electric utility engineering.



Outstanding performance is only one reason why the leading power plants continue to place repeat orders for Blaw-Knox 4-Rope Buckets.

Another reason is the dependability resulting from the many years of Blaw-Knox design experience.

Blaw-Knox Company is the foremost expert in the design of 4-rope clamshell buckets for handling coal or coke.

Experienced Blaw-Knox engineers will gladly discuss your coal or coke handling problems to aid you in selecting the correct size, weight and type bucket for your needs without obligation.

Ask for Bulletin 2392.

BLAW-KNOX COMPANY
BLAW-KNOX EQUIPMENT DIVISION
PITTSBURGH 38, PA.
Offices in Principal Cities

BLAW-KNOX
CLAMSHELL BUCKETS
FOR COAL AND COKE

The New York Central System Modernizes the Michigan Central Passenger Terminal Power Plant

By A. E. DeFOREST*

THE New York Central System through its subsidiaries, the Michigan Central Railroad and the Detroit River Tunnel Company, have recently placed in service in their Detroit Passenger Terminal three Combustion Engineering, Inc., Type 17-2VP package boilers, Fig. 2, that, together with all necessary controls and auxiliaries, make the new power plant one of the most modern in the Detroit area.

The boilers as installed are rated at a continuous capacity of 28,000 lb of steam per hour, are designed for 250 psi working pressure with safety valves set at 175 psi. Each boiler conforms to the ASME code and meets the rigid requirements of the State of Michigan as well as the City of Detroit codes. The boilers are not equipped with superheaters.

Boilers of the VP Type are usually shop assembled and installed as a unit, but due to conditions under which they were to be installed and located, it was necessary that they be shipped "knocked down" and erected on the job. This was necessary because the boiler room floor is some twenty-odd feet below the street level without access of any description other than a 4 ft by 7 ft opening through which all parts of the boilers were lowered.

The original boilers, of which there were five, Fig. 1, were of the cross-drum sectional header water tube type, built by the Toledo-Flanner Boiler Co., and installed in 1912 at the time of the erection of the then new Michigan Central Passenger Terminal. They were rated at 450 hp and safety valves were set at 150 psi. Bituminous coal was used for fuel and were fired by Green Chain Grate Stokers.

As the need for greater steam capacity became more apparent due to increased demands in the heating of passenger train cars and adjacent buildings, and taking into consideration the condition of the boilers, stokers and coal-conveying machinery, the study indicated that three Type 17-2VP Boilers, equipped with "Todd" burners for burning No. 6 or "Bunker C" oil, would satisfactorily handle the load of furnishing steam for approximately 150 passenger train cars, while being serviced, as well as the other requirements.

Replacement Problems

Owing to the fact that steam is required on a 24-hour basis, and for every day in the year, the problem of replacing the old boilers was given careful consideration. The original boilers as installed consisted of one boiler in a separate setting and two boilers each in the other two settings.

Work of dismantling the single boiler and setting was begun in March and the two boilers adjacent in May of 1954. The first two VP boilers were then erected and placed in operation on September 11, 1954. Following the placing in service of the two VP boilers, the remaining bank consisting of two boilers were taken out of service and subsequently dismantled to make room for the third VP boiler, which was erected and placed in service on January 20, 1955. Throughout the period from March until September 1954, it was possible to furnish all steam requirements with the older boilers still on the line.

The three VP boilers are so arranged in the boiler room, that if future requirements demand, space has been provided for two additional units, even to the extent of installing the necessary connections in the main steam header together with stop valves.

Fuel Selection

In the selection of the new VP boilers arranged for oil firing instead of boilers using coal for fuel, the initial savings that could be made was the deciding factor. The condition of the coal conveying system was such that complete replacement was necessary along with extensive repairs to other items.

Storage for 50,000 gal of fuel oil underground has been provided. The pump house, located 200 ft from the oil-storage tanks, has a Blackmer Mfg. Co. unloading pump, strainer and meter, all protected by an automatic CO-2 system. Oil piping is located in the tunnel formerly occupied by the coal conveyor. The pump and heater set consisting of two fuel oil pumps, each with a capacity of 20 gpm with pressure of 150 psi complete with motors and starters and two oil booster heaters, capable of heating 1000 gal of No. 6 or "Bunker C" oil per hour from 80 F to 180 F when operated at 100 psi steam pressure stands in front of the center boiler, on the boiler room floor. Remote liquid level indicators have been installed on the boiler

*Retired District Industrial Engineer, Michigan Central District.

Fig. 1—The original bank of five boilers in the Michigan Central Railroad Terminal buildings remained in service from 1912 to date employing chain grate stokers

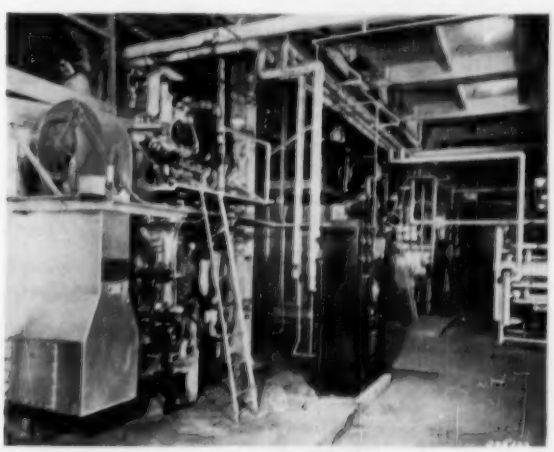


Fig. 2—Three new packaged boilers replaced the five in Fig. 1 to permit handling a greater steam demand for building and passenger trains

with ABK® METAL

pump life increase—5 to 1

. . . pipe life increase—3 to 1

Pumping 300 tons of ash per day at a large midwestern power plant, pump shells of alloy steel were averaging only six months life. Then pump shells were specified in ABK Metal—a nickel-chrome iron alloy of controlled structure with outstanding abrasion resistance. Installed in 1945, these pumps gave 31 months of service and handled 140,000 tons of ash . . . a pump life increase of over 400%.

In the same installation white iron pipe was formerly used in the ash pipe line . . . lasted no more than 2½ years. ABK pipe, installed in 1945, is still in service in many parts of the line . . . a pipe life increase of over 300%.

For economical handling of your wet or dry ash specify ABK Metal pump casings and impellers, pipes, elbows and fittings, liners, injector nozzles and similar equipment.

AMERICAN Brake Shoe COMPANY

BRAKE SHOE AND CASTINGS DIVISION
230 Park Avenue, New York 17, N. Y.

room wall close to the pump and heater set to enable the operator to determine the amount of oil in the storage tanks at all times.

Water Treatment

Taking into consideration the installation of the Type VP Boilers and their ability to maintain maximum boiler pressure at all times, proper water treating facilities have been provided. A dual unit to soften a total of 720,000 gal of water per regeneration, with a normal delivery rate to service at 333 gpm, or 20,000 gph has been installed. In addition to the dual unit pressure type zeolite water softener, a dealkalizing plant has been provided to insure the minimum of CO_2 in the steam. This equipment was considered necessary because the returns are only 25 per cent of the water required and the balance or 75 per cent is city water make-up.

In addition to the zeolite and dealkalizing systems, a 250-gal phosphate tank (24 hr capacity) and three chemical treatment pumps of 2.5 gph capacity against a boiler pressure of 200 psi have been installed. The phosphate pumps are cross-connected so that any one of the pumps may be used with any boiler that may be in operation.

As water is evaporated into steam, any solids dissolved in the boiler feedwater are left behind to concentrate in the boiler liquid. The amount of dissolved solids present in the feedwater depends upon the natural mineral solids in the raw water and the kind of water treatment employed in the boiler cycle. With a view of holding the boiler water as near the concentration limits as possible, continuous blowdown valves have been installed on each of the three boilers and the blowoff waters discharge into a centrifugal steam separating flash tank. The continuous blow off eliminates the need for intermittent blowdown of the boilers, prevents foaming or priming, removes a smaller quantity of blowoff, which gives economy of fuel, less strain on the boiler and a reduced make-up requirement. As the railroad has always considered good water treatment an asset, a thorough study was made in order to provide the necessary equipment for proper protection.

A further improvement in the feedwater equipment was also made through the installation of a 50,000 lb per hour feedwater heater with atomizing type deaerator of 29.9 psig, of plate construction, having the steel atomizing heater top mounted upon a horizontal cylindrical storage tank. This incorporates 20 min (278 cu ft) of water storage to the overflow line, a sufficient supply for all operating conditions. The condensate returned from the heating system is passed through an oil filter to remove the oil and prevent it from passing into the boilers with the feed water.

Instrumentation

To take full advantage of the flexibility of the boilers, continuity of operation at the most economical level is obtained through the use of Hays all electrically operated automatic metering type combustion control system. The master controller is mounted on the panel for No. 2 boiler with submaster controls mounted on the panels for No. 1 and No. 3 boilers.

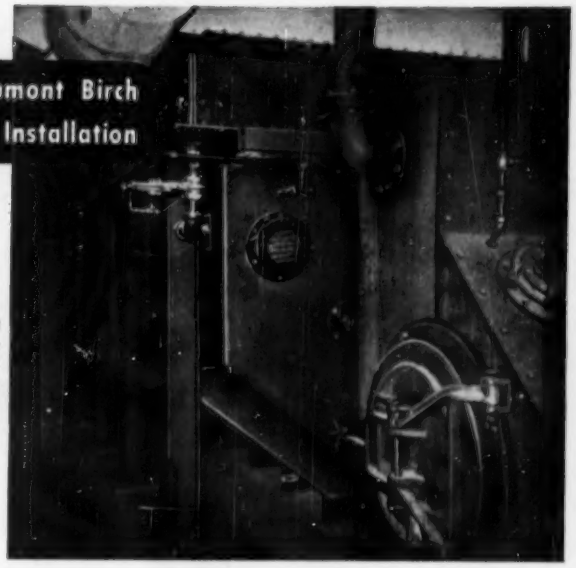
The instruments for guidance on each of the three panels consist of a steam flow meter, of the four pen type, recording steam flow, steam pressure, air flow and flue gas temperature. On the panel board, there is also mounted, at the top, a 12-in. steam gage, with 5 psi graduations and 25 psi increments indicated by large plain figures, to a pressure of 50 per cent in excess of design pressure with the 175 psi mark (safety valve setting) at top center. Oil supply pressure, oil return line pressure and oil temperature gages are also included, all located conveniently for instant observation. The arrangement of the control system is therefore quite flexible allowing load distribution between boilers as dictated by best operation.

The boilers are completely automatic in operation, being equipped with the Fireye FP-2 System providing complete automatic starting and operating flame failure protection. This system uses the new "Firetron" cell which visually supervises the oil flames. The single-type scanner in conjunction with the programming control monitors both main and pilot flames and does not allow the main fuel valve to open unless the pilot flame has been established.

The system causes immediate shutoff of all fuel after a flame failure and the control programs the operating sequence of blower and burner motor, ignition system, fuel valve, and modulating motor. It also provides a purge period both before and after each firing period. The control cycles automatically each time that operating or limit control closes and after power failure, but must be reset manually following flame failure. The Fireye FP-2 System includes a safe-start feature whereby component failure within the equipment or the presence of actual or simulated flame prior to startup will prevent burner operation. This type of control is located on each of the panel boards.

Engineering, specifications and installation of all equipment was arranged for in the office of Mr. F. H. Simpson, Chief Engineer of the New York Central System, located in the LaSalle Street Station, Chicago, Ill., and designed under the direct supervision of Messrs. A. M. Westenhoff, Engineer of Construction, and J. E. O'Brien, Mechanical Engineer.

Another Beaumont Birch Ash Handling Installation



Discharge end section of a flooded hopper for Beaumont hydraulic system showing rugged supporting structure and circular protected observation ports of special heat resistant glass.

Why BEAUMONT BIRCH Hydraulic Ash Handling Systems Assure You

Reliable, Efficient Service

In every detail of Beaumont Hydraulic Ash Handling Systems, you'll find they're designed for practical considerations of boiler efficiency, operating safety, minimum man-hour attention and minimum maintenance.

For example, on flooded hoppers beneath pulverized coal fired boilers, costly shut downs are never necessary when water jet nozzles in the ash hopper require replacing. They are easily and safely replaced *while the boiler is in operation* . . . the rugged sluice gate and operating cylinder are mounted on a single casting, completely shop assembled. This assures perfect alignment of cylinder for long uninterrupted service.

On flooded hoppers, operators are always protected at observation ports by special glass resistant to thermal shock, in addition to a protecting metal guard. Built-in spray washers keep all observation ports clean and free from dirt and fog.

These and many other points, such as, sluiceways, sumps, dewatering bins, flyash handling systems and other supplemental equipment are only a small part of the attention to details that are characteristic of Beaumont Birch Systems.

Power and Consulting Engineers specify Beaumont Birch Hydraulic Ash Handling Equipment because they are assured of design, engineering and construction to exacting specifications!

Beaumont's background of over fifty years in the design and manufacture of ash handling systems gives you long service life with a minimum of maintenance.

For complete details of the many efficiency and economy features of Beaumont Hydraulic Ash Handling Systems, call in a Beaumont Birch engineer or write direct.

Beaumont BIRCH COMPANY

1506 RACE STREET, PHILADELPHIA 2, PA.

DESIGNERS — MANUFACTURERS — BULK MATERIAL HANDLING SYSTEMS

Make boiler water level reading
positive—mistake-proof—with
EYE-HYE
Remote Reading Indicator
Gage reading at eye-height any reasonable distance from drum
Easy to read, like conventional gage
Illuminated green fluid gives sharp clear indication
Simple, manometer principle, no complicated working parts
Easy to install, practically no maintenance
Models for all pressures, from 0 to 2000 pounds
Panel-mounted EYE-HYE
Wall-mounted EYE-HYE
Write for full data on EYE-HYE—tell us working pressure and control location
Complete line of Water Columns, Gages and other trim for all working steam pressures.
Reliance EYE-HYE
The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland 3, Ohio
Reliance EYE-HYE
Remote Reading Gage
All-hydrostatic • Reads like a tubular glass gage

Utility Orders Subcritical Pressure, Once-Through Boiler

An innovation in American power practice was disclosed in the recent announcement of the Dayton Power & Light Company, Dayton, Ohio, that it has placed a contract with Combustion Engineering, Inc., New York, for a C-E Sulzer Monotube Steam Generator.

Although this is the second C-E Sulzer Unit to be ordered in this country, it will be the first of the "once-through" type to operate at a steam pressure in the subcritical range and will be larger than any such unit elsewhere.

The previous unit, ordered last year by the Philadephia Electric Company, is designed for the supercritical pressure of 6000 psig—the highest steam pressure adopted to date anywhere in the world. The steam temperature for this unit, 1200 F, also establishes a new world record. Only one other supercritical pressure boiler has thus far been ordered in America, and there are none installed abroad.

Although the Dayton installation will be the first "once-through" boiler in this country for conventional pressure, there are a large number of such installations in Europe where metal shortages and other factors have favored the use of drumless type boilers. Sulzer Bros., Ltd. of Winterthur, Switzerland, has long been a leader in the European development and application of "once-through" boilers. Through a license and technical assistance agreement, consummated two years ago, Combustion is in a position to offer designs reflecting Sulzer's 20 years of experience in the design, manufacture and operation of "once-through" boilers.

While this type of boiler is the only type suitable for supercritical pressures, in the conventional range it must compete with American designs which have established outstanding records of economic performance and reliability. Notable among these is the C-E Controlled Circulation Boiler, a design especially suited to the higher range of subcritical pressures (2200–2700 psig) now indicated as the pressure range most likely to be adopted for the large utility installations that will be ordered in the next few years. Both the controlled circulation and once-through designs have special features, the evaluation of which with respect to load, operating and other conditions of particular plants will simplify the problem of selection.

The Dayton unit is to be installed at the Company's Frank M. Tait Station in Dayton where it will serve a 125,000-kw turbine-generator. It will supply steam at a pressure of 1800 psig, with a primary steam temperature of 1000 F, and a reheat temperature of 1000 F.

Business Notes

Two major electric power plants, the largest ever built by private industry when completed, are now officially in operation. The **Ohio Valley Electric Corp.** announced that its Clifty Creek Plant at Madison, Ind., and Kyger Creek Plant at Cheshire, Ohio, are delivering kilowatts to the U. S. Atomic Energy Commission's gigantic new uranium diffusion plant near Portsmouth, Ohio. The first 200,000-kw turbo-generating unit at each of the two plants has been placed in service after several weeks of test, and their power is being delivered to the Portsmouth project via OVEC's new 330,000-volt transmission system.

The **Burns & Roe, Inc.** proposal which involves association with **J. Rich Steers, Inc.,** and **Hatzel & Buehler, Inc.,** also of New York, has been selected by **Duquesne Light Co.** as the most favorable of five proposals for the general contractor work in connection with the construction and installation of the conventional portion of the central station atomic power plant at Shippingport, Pa. The work of the construction firms will be limited to the turbine-generator portion of the plant, but Duquesne, subject to the approval of the U. S. Atomic Energy Commission, may assign to these firms certain work on the nuclear reactor portion of the plant costing up to an amount equal to Duquesne's participation in the reactor portion of the atomic plant.

The nation's maintenance expenditures will increase by one billion dollars in 1955, according to H. F. McCullough, general manager of **General Electric Co.'s** Service Shops Department. This maintenance figure will be approximately nine per cent higher in 1955 than last year's outlay. He based his forecast on an increasing industrial trend towards the use of automation, or automatic methods for continuous manufacturing processes.

There are now 1440 American Standards in use in the United States according to the annual report of the **American Standards Assoc.** The number of standards approved in 1954, was 152, as reported by vice admiral George F. Hussey, Jr., USN (ret), managing director of the American Standards Association. Of these, 64 were new standards, 88 were revisions. The greatest number of new standards was in the electrical field.

A contract for the design, engineering, and construction of a nuclear reactor has been awarded to the **American Machine and Foundry Co.,** New York by **Battelle Institute,** Columbus, Ohio. One of the first in the country to be owned and operated by a private organization, the reactor will be a key component in a $1^1/_2$-million-dollar atomic research center Battelle is building fifteen miles west of downtown Columbus.

How coal and allied industries are using research as a market building device was discussed when **Bituminous Coal Research, Inc.,** held its annual meeting April 13 at the William Penn Hotel in Pittsburgh, Pa. BCR's Second Techno-Sales Conference, whose objective is to help correlate the industry's research activities to coal's market-building efforts, was held on April 12.

To improve service to their customers and facilitate the development of high quality in all of its products **The Wayne Pump Co.** has been organized as two autonomous operations. These are to be the Petroleum Marketing and Automotive Equipment Division located in Salisbury, Md. and the new Industrial Division in Fort Wayne, Ind.

The board of directors of the **American Institute of Electrical Engineers** announced in early February that it has received a report of a special committee of representatives of the five engineering societies recommending "that the headquarters of the engineering societies be located on one of the sites in the city of Pittsburgh. A board spokesman said that the report also recommended that "the four founder societies liquidate the **United Engineering Trustees** and join with the **American Institute of Chemical Engineers** in the formation of a new corporation to build, operate and maintain the new engineering center." The spokesman said that a special meeting of the AIEE board of directors would be called to consider the report. No date was set for the meeting.

Completion of **Westinghouse Electric Corp.'s** $32 million expansion program at its Steam Division, South Philadelphia, Pa., has more than doubled the division's productive capacity for steam turbines and associated equipment. In addition to the division's greatly expanded manufacturing and testing facilities now available, a new $6 million steam- and gas-turbine research and development laboratory has been completed.

Announcement has been made of the appointment of **Central Pump & Equipment Co.** of St. Louis, Mo., and **The Hesler Co.** of Kansas City, Mo., as representatives for Copes-Vulcan

Make your own
VITRALLOY
mid-year
CHANGE-OVER TEST

ORDINARY STEEL TUBES

BARROW'S VITRALLOY PREHEATER TUBES

When you re-tube preheaters this summer make your own convincing test of Barrow's VITRALLOY. Install a representative section of these clogging and corrosion free tubes . . . side-by-side with the ordinary steel tubes you usually use. Then compare operational performance . . . watch just a plain water wash down keep VITRALLOY free and clear . . . see how they outlast ordinary steel tubes (of same wall thickness and installed at same time). VITRALLOY Tubes (boro-silicate compound fused to base metal) resist corrosion . . . nip the vicious cycle of clogging and more corrosion before it starts. VITRALLOY also permits saving and re-use of more degrees of heat from flue-gas.

HOW TO MAKE YOUR VITRALLOY TEST

Get set by ordering your change-over tubes now . . . or if you prefer to first look at a "desk size" 6" length of VITRALLOY Preheater Tube, drop us a line. For each of your units, be sure and let us know the number, length and diameter of tubes . . . also sulphur percentage of your fuel.

BARROWS B P PORCELAIN

BARROWS PORCELAIN ENAMEL CO.
LANGDON RD. AND PENN. R. R. CINCINNATI 13, OHIO
Phone: REdwood 6000

Installing a 5½" thickness of Moldit Chrome with a cement gun in one of 17 large slagging bottom boilers in one plant. All were lined with Moldit Chrome. It can also be poured in place like concrete.

as much as 10 Years without failure in slagging type boiler floors

Moldit Chrome has proved itself over a period of 10 years' service in floors of both slagging type and oil-fired boilers. There has not been a single reported case of failure.

For this tough service Moldit Chrome has no equal, and has saved many boiler outages in plant after plant.

Shot on studded tubes of boiler walls, Moldit Chrome has been in continuous service for 8 years without a pound of replacement.

Easy to install with a cement gun or pour in place... Dries without shrinkage, leaving no crevices or cracks in the floor for slag to get through.

It takes no pounding or ramming to install this material.

Moldit Chrome costs less. Saves time and labor. Write for Catalog R-54.

Moldit Chrome

CASTABLE REFRACTORY CEMENT

Pour it—Gun It—Save Money—Save Days

REFRACTORY & INSULATION CORP.

R&I

REFRACTORY BONDING AND CASTABLE CEMENTS
INSULATING BLOCK, BLANKETS AND CEMENTS

124 WALL STREET • NEW YORK 5, N. Y.

products, by **Copes-Vulcan Division,** Continental Foundry & Machine Co., Erie, Pa.

The Atomic Energy Commission and **The American Society of Mechanical Engineers** will share the cost of a $25,000 engineering project to develop information in the field of high temperature piping. The investigations will be performed by the AEC's Knolls Atomic Power Laboratory, Schenectady, N. Y., which is operated by the **General Electric Co.** The ASME, on behalf of American industry, will contribute $10,000 and a group of ASME technical experts will be available at no cost to the government for consultations in the programing and evaluation of the work.

The Chamber of Commerce of the United States has announced the appointment of an Atomic Energy Committee to encourage development and use of atomic energy by private enterprise. The new committee will be under the chairmanship of Edwin D. Canham, Editor of the Christian Science Monitor and a Chamber director.

The Schneider Manufacturing Corp. of Muncie, Ind., a wholly-owned subsidiary of the **Westinghouse Electric Corp.,** has been dissolved to form the Hydraulic Drives Department of the Westinghouse gearing division. The Schneider Manufacturing Co. was purchased by Westinghouse in October, 1954. The new department will sell, engineer and manufacture hydraulic torque converters and associated brakes and transmissions.

Lewis L. Strauss, chairman of the **Atomic Energy Commission,** recently announced the Commission has approved a proposal by the **Seminole Electric Cooperative, Inc.,** of Madison, Fla., to study the feasibility of small central station nuclear power plants. The study will be performed under the AEC's Industrial Participation Program which has been underway since 1951.

Chicago Heater Company has announced the appointment of **Turbine Equipment Co.** as its representative to handle the sales of deaerating heaters in territories served by the latter concern. Turbine Equipment Company has been engaged in the sales of feedwater heating apparatus and other power plant and industrial plant equipment for more than 20 years.

The Carter Craft fin tube process, a new method of heliarc welding longitudinal fins to tubes for use in heat exchangers, has been acquired by **American Locomotive Company.** The company has also announced the production of a new line of fin tube heat exchangers for the petroleum, chemi-

cal, petrochemical and power industries, which employ the advance-design tubes in their construction.

Panellit, Inc. has acquired the **Jordan Electronic Mfg. Co., Inc.,** of Pasadena, California, a leader in the radiation monitoring field. Panellit is engaged in the manufacture of modern automatic control and data reduction information systems used to promote efficiency of complex industrial manufacturing and commercial operations. Panellit plans to accelerate research and development activities of Jordan in the field of industrial measurements in addition to its activities in the nuclear field.

A new non-profit corporation, **Atomic Power Development Associates, Inc.,** has been formed to carry on research in which its organizers have been engaged. Walker L. Cisler, newly elected president, was the former management committee chairman for the thirty-three companies which have been cooperating in atomic power research under a contract with the Atomic Energy Commission. Offices will be maintained in New York and Detroit.

Engineers Jount Council has announced that it is assembling a "Finder's List" of key members of the profession throughout the nation who would assist in locating engineering talent needed in time of national emergency. The work is being done in cooperation with the **National Science Foundation,** of Washington, D. C., which Congress directed to establish the National Register of Scientific and Technical Personnel. Engineers Joint Council has undertaken to maintain the engineering phase on a current basis.

With construction already well under way, the new building in Michigan City, Ill. to house both plant and general offices of the **F. W. Dwyer Mfg. Co.,** is scheduled for completion sometime in July of this year. In addition to being considerably larger than the present quarters, the new plant, designed specifically for its owners, should materially increase production facilities on draft gages, manometers, filter gages, and other instruments manufactured by Dwyer.

While the scientific world, as reported in recent events, discusses the seven wonders of the ancient world, the civil engineers of this country are pondering which of its multitudinous achievements may be designated the Seven Engineering Wonders of the United States. There were almost 300 great works named by the 30 sections of the **American Society of Civil Engineers,** but it has not been decided which of these belong on a list of seven.

TAYLOR COMPARATORS

"never knew BOILER WATER pH and PHOSPHATE TESTS could be so easy!"

Just fill 3 test tubes with the sample to be tested and place them in the base...

add reagent to middle tube only...

place color standard slide on base. Move the slide across until the colors match and...

There's the Value!

You can make pH, chlorine, phosphate or nitrate determinations with these 3 easy steps with Taylor Comparators. Complete water analysis, including fluorides, is only a little more detailed when you use a Taylor Water Analyzer. Taylor sets are lightweight, durable, portable. Many different tests can be made on a single base. Best of all . . .

COLOR STANDARDS ARE GUARANTEED

Taylor liquid color standards carry an unlimited guarantee against fading, thus there's no chance of mechanical inaccuracy. Since a complete set of standards for any one determination is enclosed in a sturdy plastic slide, there's no need to handle fragile single standards.

SEE YOUR DEALER for Taylor sets or write direct for FREE HANDBOOK, "Modern pH & Chlorine Control." Gives theory and application of pH control, illustrates and describes full Taylor line.

SERVING SCIENCE AND INDUSTRY 1930 1955 FOR 25 YEARS

W. A. TAYLOR AND CO.

416 RODGERS FORGE RD • BALTIMORE, MD

Personals

The appointment of **Rear Admiral Wilson D. Leggett, Jr.,** USN, chief of the Navy's Bureau of Ships, as vice president of engineering of American Locomotive Co., was announced recently. Admiral Leggett's appointment became effective upon his retirement from the Navy on March 31.

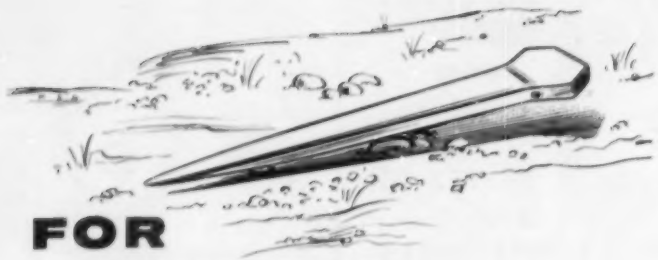
Paul B. Shiring, formerly sales executive for Westinghouse at Buffalo, New York, has been named electric utility manager for the Northeastern region of Westinghouse Electric Corp. In his new post, Mr. Shiring will have charge of the sale of apparatus for the generation, transmission and distribution of electric power to electric utility organizations throughout an area comprising all of New England, New York State, a part of Northern Pennsylvania and the northern half of New Jersey.

A number of changes among the district sales offices of the tubular products division has been announced by The Babcock & Wilcox Co. **F. T. Murphy, J. N. Rogers** and **C. J. Ponsot** have been named to handle the sales of the division's products in the St. Louis area. **A. M. Johnson** has moved into the sales headquarters in Houston and **G. H. Weight,** southwestern sales manager, is in charge of all tubular products division sales in the New York area.

Charles Grosjean, who has had many years of field experience and knowledge of Yarway products, is now New York district manager of Yarnall-Waring Co. He succeeds **J. A. Steer** who was recently made manager of boiler trim division in Philadelphia. Other new additions to the New York sales office are **J. F. Curran,** serving Connecticut, New York and western New England, and **R. T. Dewhirst,** in the north New Jersey and surrounding area.

Leonard L. Youell has been appointed vice president and general manager of Stone & Webster Canada Limited, with headquarters in Toronto. Mr. Youell joined Stone & Webster in 1945 to be its engineering representative in Canada. Upon formation of Stone & Webster Canada Limited in 1950, he became manager of its principal office in Toronto.

The sales and service facilities of the Wheelco Instruments Division, Barber-Colman Co., Philadelphia office have been expanded with the addition of new personnel. **H. V. King,** formerly of the Chicago Wheelco office, is now with the Philadelphia office. **Harold Sieber,** of Philadelphia, has joined the service organization.



FOR WANT OF A NAIL...

Something that wasn't there once cost a king his life.

For today's boiler, lack of internal protective surfacing is hardly a life or death matter. Yet consulting engineers . . . insurance underwriters . . . power plant operators increasingly specify, recommend, and purchase Apexior Number 1 for tube and drum coating. Why?

Because the yardstick of return on investment proves Apexior's unique service *now pays off at the highest rate ever* . . . for modern boiler design and operation today permit a single Apexior application to deliver maximum protection not only for a normally anticipated five years, but for one — three — sometimes even *five years more!*

And because Apexiorizing is now a one-coat procedure, former material and labor estimates are halved. Protection that can last twice as long today costs *half as much* . . . a trifling pennies-per-square-foot premium to insure full return on a major capital investment.

Like the legendary nail, boiler protective coating may seem a factor of small significance — yet it can mean the difference between acceptable performance and the best of which the modern boiler is capable. The assurance every inspection gives that tubes and drums are functioning at new-metal peak efficiency is the measure of Apexior's service in maintaining highest steam production reliability and quality — a contribution measured ultimately in profit dollars.

Internal boiler protection is but one phase of Dampney corrosion-control activity. Dampney Coating Systems for specified end-use service protect cooling towers — intake water structures — pipeline interiors. For a recommendation to meet your requirements, write

MAINTENANCE FOR METAL

THE DAMPNEY COMPANY

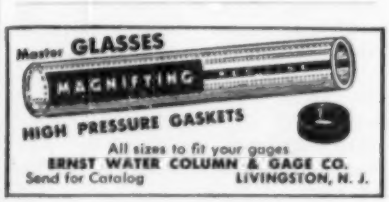
HYDE PARK, BOSTON 36, MASSACHUSETTS

D. S. Walker Elected Director of C-E, Inc.

Donald S. Walker, vice president and director of sales of Combustion Engineering, Inc., has been elected a director of the company. A graduate of the U. S. Naval Academy, Mr. Walker began his business career as a sales engineer with D. H. Skein & Company of Chicago. Subsequently he became a vice president of that company and an officer of a subsidiary. In 1934 he joined the sales department of Combustion Engineering's Philadelphia district office, and shortly thereafter became district manager. In 1939 he was transferred to New York as general sales manager of the company, and in 1941 was elected vice president in charge of sales. Mr. Walker has long been active in the affairs of the Naval Academy Alumni Association having served as a trustee for six years, vice president for two years and president for two years (1949–1951).

Hilton A. Levonian is the new vice president in charge of consulting engineering of The Kuljian Corporation, according to an announcement by Arthur H. Kuljian, vice president, engineering.

A. W. Cash Co. has announced the appointment of **H. M. Kirkby** to the new position of director of marketing.



The National Society of Professional Engineers annual award for meritorious service will be presented to **Dr. Andrey A. Potter,** Dean Emeritus of engineering at Purdue University, on June 4 at the society's annual banquet. The award was made to Dr. Potter because of his inspired teaching and sympathetic encouragement of individual students of engineering, his wise counsel in the field of engineering education, his leadership in raising the status of the profession, and his manifold services to the Nation.

Newly elected vice president in charge of sales of the Lunkenheimer Co. is **Melvin W. Pauly.** Mr. Pauly was formerly general sales manager.

The board of directors of The Hays Corporation, at its quarterly meeting, elected **Orval W. Riggs** to the position of vice president in charge of sales, and approved the appointment of **Louis E. Hapke** to the position of controller. Riggs has been with The Hays Corporation since 1934 serving as project engineer, chief project engineer, and for the past two years as sales manager.

The Kerite Company, manufacturer of insulated wire and cable, announced the promotion of **L. W. Eighmy, Jr.,** to manager of its power department. He will be in charge of sales and engineering for industrial and power customers throughout the country.

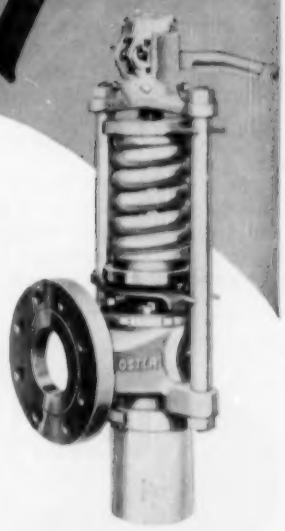
According to an announcement by **Henry W. Foulds,** president of The Permutit Company, **Sheller L. Steinwender** has been appointed vice president. Before joining The Permutit Company, Mr. Steinwender, a chemical engineer, was vice president of the Scaife Company in Pittsburgh.

Announcement was made recently of the appointment of **Edward D. Flavin** as vice president of the Johns-Manville Sales Corporation and manager of Special Industries, industrial products division. Mr. Flavin succeeds **L. A. Baldwin,** who retired after a thirty-five year career with the company.

General manager, **K. D. Nichols,** announced the establishment of a division of licensing in the Atomic Energy Commission staff, and the appointment of **Harold L. Price** as director. The division will be responsible for the preparation and administration of commission regulations dealing with the licensing of private atomic energy activities and related matters under the Atomic Energy Act of 1954.

Dr. Charles M. Herzfeld, physicist, has joined the heat and power division, of the National Bureau of Standards. He will be consultant to the chief of the heat and power division for mathematical and theoretical physics and

SAFEST



On thousands of boiler drums, superheater outlets, reheater inlets and reheater outlets, Foster Type 38-SV Super-Jet Safety Valves are being used for the unprecedented factor of safety they offer in today's elevated operating pressures and temperatures. Designed for 3000 psi, several Super-Jets are now in service at pressures as high as 2700 psi and 1100F.

There are also many Super-Jets set to pop at pressures ranging down to as low as 8 psi in turbine relief service and reducing valve stations.

Regardless of operating pressures or temperatures the Foster 38-SV Super-Jet Safety Valve guarantees you a positive factor of safety in protection of life, limb and property from overpressure.

FOSTER ENGINEERING COMPANY

835 LEHIGH AVENUE — UNION, N. J.

AUTOMATIC VALVES — SAFETY VALVES — FLOW TUBES

EXTRA YEARS

OF MORE DEPENDABLE POWER

and at less cost per pound of steam

TODD BURNERS

GAS OR OIL

PRODUCTS DIVISION

TODD SHIPYARDS CORPORATION

HEADQUARTERS: Columbia & Halleck Streets, Brooklyn 31, N. Y.

PLANT: Green's Bayou, Houston 15, Texas

TODD NEW YORK, TEXAS

physical chemistry. Among other problems of the division, he will be engaged in problems of high temperatures.

Robert L. Seitz has joined the Philadelphia sales office of American Water Softener Company as sales engineer. He is a chemical engineer and, prior to coming to American, has been connected in a sales capacity with Cochrane Corporation and Infilco.

The annual ASME Medal, which is administered by the board of honors of The American Society of Mechanical Engineers, for distinguished service in engineering and science will be presented to **Granville M. Read,** chief engineer of E. I. du Pont de Nemours & Co., Inc. The citation accompanying the medal praises Mr. Read for his outstanding leadership in developing men and in organizing and completing projects of extraordinary national and industrial importance.

The electro-alloys division of American Brake Shoe Company has appointed **Frederick T. Jordan** as eastern district sales manager. Formerly sales engineer, Mr. Jordan has been with Brake Shoe since 1946.

Harry M. Spring, Jr., has joined the Mathis Water Treating Company of Knoxville, Tennessee, in the capacity of chief engineer. Mr. Spring is a member of the ASME, American Society of Metals, Non-Destructive Testing Society, and other engineering groups.

Walworth Company has announced the promotion of **T. D. Hyatt** to assistant treasurer. Hyatt, who has been with Walworth since 1941, formerly was assistant secretary of Walworth International Company, a subsidiary of Walworth Company.

Election of Manning, Maxwell & Moore, Inc.'s board of directors has been announced by **Hamilton Merrill,** president of the company. **J. Robert Kelley** is executive vice president, **Chester H. Butterfield,** vice president of operations, and **Charles A. Moore** as vice president and treasurer.

C. Harold Berry, Gordon McKay professor of mechanical engineering at Harvard University and a leader in the field of heat engineering, will retire this summer. Prior to joining the Harvard faculty in 1928, Prof. Berry had served as assistant to the chief engineer of the Detroit Edison Co., and as associate editor of *Power* magazine.

New executive appointments in two divisions of the American Brake Shoe Company were announced recently. **John S. Hutchins,** a vice president of the company since 1946, and president of Ramapo Ajax division, has been named to additional duties as president of national bearing division. **Thomas W. Pettus,** also a vice president since 1946 and formerly president of the national bearing division, is assigned to overall railroad sales for the company.

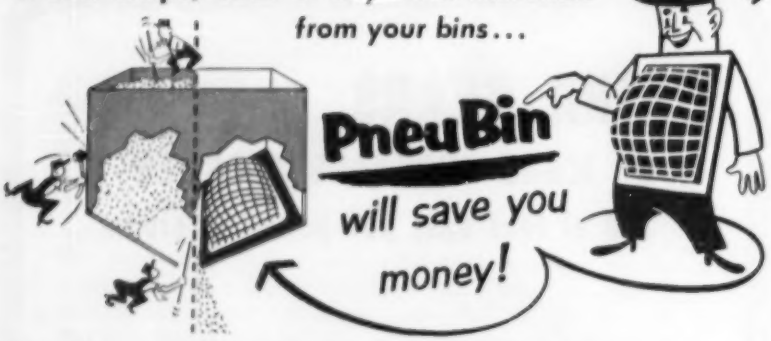
Appointment of **Charles R. Gibbs** as supervisor of mechanical service and erection succeeding **L. L. Chapotel,** retired, has been announced by **C. B. Smith,** manager of Allis-Chalmers Mfg. Co.'s service section. Mr. Chapotel joined Allis-Chalmers in 1907 and served almost 48 years in the service section prior to his retirement March 31.

Robert E. Navin has joined The Hays Corporation, Michigan City, Indiana, as assistant to the executive vice president. In his new position Navin will be concerned primarily with engineering activities of the company. For the last six years Mr. Navin has been associated with the Detroit Bevel Gear Company in the capacities of special projects engineer, chief engineer and assistant to the president.

L. J. Wing Mfg. Co., Linden, New Jersey, announced the following new officers: **H. S. Wheller,** president and general manager; **C. H. Smith,** vice-president and treasurer; **H. S. Wheller, Jr.,** vice-president and secretary;

PULSATING PANELS
eliminate flow stoppage in bins!

If you have trouble moving—
Difficult Chemicals, Sand, Clay,
Wood Chips, Coal *or any other materials*
from your bins...



PneuBin will solve your flow stoppage problems and reduce your operating expense. The PneuBin unit consists of steel-backed, neoprene, pulsating panels mounted on the inside wall of your present bins and air controls to regulate the panels' action. By the pneumatic inflation and deflation of the PneuBin panels, the bin contents are positively displaced to insure free flow. After the panels have deflated, the air control unit (operating off the regular plant air supply) starts another cycle of inflation and deflation. The process continues *automatically* at whatever frequency is set on the air controller (this frequency is adjustable).

PneuBin decreases plant operating costs by reducing maintenance, insures constant material flow to production lines and greatly increases personnel efficiency through its quiet operation.

Send for "Flow Stoppage Report" and FREE literature. PneuBin engineers will gladly make recommendations with no obligation on your part.

PneuBin
A PRODUCT OF
GEROTOR MAY CORPORATION
1529 Maryland Ave., Baltimore 3, Maryland

T. R. Peyrek, vice-president in charge of heating and ventilating division and **C. R. Mayer,** assistant treasurer.

Arthur H. Sisson has been named manager of advance engineering of the General Electric Company's small turbine and supercharger department. At the same time the appointment of **Richard A. Baker** to the position of engineering administrator to succeed Mr. Sisson was announced.

The University of Wisconsin recently gave a citation to its engineering school graduates for outstanding accomplishments in their fields. One of these was **Irving L. Wade,** general superintendent of generating stations for the Commonwealth Edison Co., Chicago. Mr. Wade has been engaged in the public utility field since his graduation in 1923, and has become a nationally known authority in the field of steam generators and steam turbines.

Julius C. Hydrick recently was made works manager, Quaker Rubber Corporation, Division of H. K. Porter Co., Inc.

Effective immediately, **Harry J. Douglas** has been appointed manager of the Pennsylvania Crusher Division of the Bath Iron Works Corporation, succeeding **John A. Plimpton.**

Albert Lob Maschinen - und Apparatebau G.M.B.H. of Dusseldorf, Germany, have appointed **H. E. Overacker,** New York, N. Y., as their exclusive sales representative in the U.S.A. and Canada.

Robert S. Stevenson has been elected president of Allis-Chalmers Manufacturing Company, by the board of directors to succeed the late **William A. Roberts** who died April 12. Stevenson has been executive vice president of the company since July, 1952.

The Foxboro Company recently announced the appointments of **C. C. Fuller** as vice president, augmenting the sales management staff, **H. O. Ehrisman** as general sales manager, and **J. J. Burnett** as field sales manager. **C. Schwarzler** will continue to direct Foxboro's expanding international operations. Vice president **C. E. Sullivan,** has retired.

H. R. Fosnot, sales manager of Graver Water Conditioning Co. announced the appointment of the Allen-Shuff Corp. of Memphis and Nashville as sales representatives. Their territory will include all of eastern Arkansas, northern Mississippi and western Tennessee from the Tennessee to Mississippi Rivers.

Obituaries

David W. Stewart, chief engineer for New Orleans Public Service, Inc., power division, died Wednesday, February 23, 1955, at the age of 65.

A native of Scotland, Mr. Stewart became associated with NOPSI in 1917 as chief engineer of the Market Street steam-electric generating station. At the time of his death he was in charge of mechanical operation of the Market Street station and the Industrial Canal station.

Henry V. Nye, retired consulting engineer for switchgear equipment at Allis-Chalmers Mfg. Company, died February 28 at his home in Milwaukee. He was 69 years old. Mr. Nye has been associated with Allis-Chalmers for 48 years and for many years has been engineer-in-charge of switchgear design. He was a fellow of the AIEE and had been active on various of its committees.

W. A. Roberts, president of Allis-Chalmers Manufacturing Company since February 1951, died suddenly April 12 following a heart attack. He was 57 years old.

ERNST
SIGHT FLOW INDICATORS
"See What Goes On Inside"

For insertion into pipe
FOR EVERY APPLICATION
BRONZE, IRON, STEEL, STAINLESS STEEL

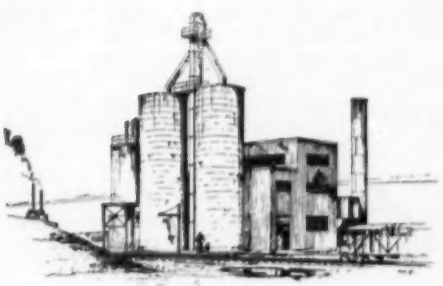
FIG. 29 Cylinder with Impeller
FIG. 17-28 Cylinder
FIG. 215 Flanged
FIG. E-57 Double Window
FIG. 212 Visibility Welding Neck or Screw
FIG. E-811 Flapper
FIG. E-1810 Rotating Wheel Type

All sizes up to 6" *Send for Catalog*

ERNST WATER COLUMN & GAGE CO.
LIVINGSTON, N. J.

Modern Design for the MODERN COAL

The Fairmont Coal Bureau has made available to consulting engineers and equipment manufacturers a TYPICAL DESIGN for the small industrial steam plant. Prepared as a guide to good engineering it achieves maximum economy of investment and engineering costs, while featuring:



- Fuel flexibility
- High efficiency
- Low fuel costs
- Minimum labor requirements
- Cleanliness, Automaticity, Reliability

Fairmont Pittsburgh Seam Coal is the MODERN COAL. Enormous reserves and inherently favorable mining conditions guarantee ample supply and low production cost. Modern mining and preparation facilities assure uniform quality.

Fairmont Coal Bureau engineers are freely available to help you solve fuel and combustion problems. Write for technical Reference Bulletins and other valuable publications.

FAIRMONT COAL BUREAU
Dept. DC, 122 East 42nd St., New York 17, N. Y.

BOOKS

1—Mechanical Engineering Thermodynamics

By David A. Mooney

540 pages Price $9.35

A vast amount of very readable information is contained in the 540 pages of this book. While written primarily as an instruction text, it is also well suited to the needs of the practicing engineer as a reference book.

Although a limited amount of elementary calculus has been employed, principally in connection with process calculations, this need not detract from the readability of the text by those who may have become rusty in mathematics, for the various explanations are clear.

The first and second laws of thermodynamics are explained at length, and the twenty-five chapters include those on properties of pure substances, gases and steam; also discussion of various cycles, nozzles and orifices, steam turbines, internal-combustion engines, gas turbines and refrigeration. All of these are amply illustrated by diagrams and the text is in line with up-to-date practice as concerns pressures, temperatures and reheat.

An appendix contains tables on different gases, combustion data, conversion units and specific heats of gases, as well as properties of air, steam, ammonia and mercury. Also, a number of large working charts are contained in a jacket. These deal, in part, with pressure-enthalpy for freon, temperature-entropy for air, a Mollier diagram for steam, temperature-entropy for CO_2, products of combustion and theoretical fuel-air mixtures.

2—High-Temperature Alloys

By Claude L. Clark

383 pages Price $7.50

This is a book intended for those who develop and use high-temperature alloys. It is also suitable for use as a text and reference book and should be of considerable assistance to those organizations having high-temperature testing laboratories. The approach is basically a metallurgical one.

An introductory chapter takes up industrial trends which have prompted interest in high-temperature alloys. Next are considered the mechanism of plastic deformation, desirable qualities for high-temperature service, and methods of testing. Considerable attention is given to creep strength and to methods for evaluating load carrying ability. The largest portion of the book concerns properties of various alloy steels, including low and intermediate alloys, stainless steels, bolting steels and those for extreme high-temperature service. There is a very interesting chapter covering nine types of service failures. Concluding chapters take up physical constants, properties at hot-processing temperatures, selections of material for specific applications and typical specifications and codes covering high-temperature.

3—Power Plant Engineering
3rd Edition

By Frederick T. Morse

687 pages Price $8.75

Subtitled "The Theory and Practice of Stationary Electric Generating Plants," the drastically revised Third Edition of this well-known text attempts to meet the needs of the engineering student, the consulting engineer and the plant operator. Emphasis is placed upon the power plant as an integrated assembly, and there is more attention given to the small plant than was the case in previous editions. The author provides the following basic definition.

"Power plant engineering is the art of selecting and placing the necessary power-generating equipment so that a maximum of return will result from a minimum of expenditure over the working life of the plant; and the operation of the completed plant in a manner to provide cheap, reliable and continuous service."

An introductory chapter provides background information on thermodynamics and gives a description of the function of consulting engineers in power plant design. Subsequent chapters take up the variable load problem and power plant economics, including depreciation methods and an introduction to rate making. Following this general presentation are chapters on the power plant building, fuels and combustion, internal-combustion-engine and gas-turbine power plants, vapor cycles and energy flow, steam generators and prime movers, gas and feedwater loops in steam plants, piping systems and instrumentation. At the end of most chapters is a set of problems without answers. A brief bibliography and an appendix conclude the work.

4—Pumps
2nd Edition

By F. A. Kristal and F. A. Annett

Price $6.50

This book covers pumps of many types and designs, how to select and install them, how to operate and maintain them, and how to locate and remedy pump troubles. Intended for use by designers, manufacturers, sales representatives and operators, it discusses a wide range of pump applications, including boiler feed, paper stock, deep-well, sewage and sludge, chemical, food product, oil field, gasoline line, fire, mine, etc.

Performance features of the various types are explained, as are their service limitations. Likewise covered are construction features, the materials used in manufacture, and the operations of particular types. In addition, practical methods are given for fiugring the head, economical pipe sizes, various combinations, etc.

This completely revised edition covers new designs, materials and applications developed since the first edition, including the latest technical advances in diaphragm, variable-displacement, proportioning, self-priming, regenerative turbine, rotary, jet and many other types.

COMBUSTION PUBLISHING COMPANY, INC., 200 Madison Avenue, New York 16, N. Y.

Enclosed find check for $..... for which send me books listed by number.

NAME _____ **Book Nos.** _____

ADDRESS _____

Postage prepaid in the United States on all orders accompanied by remittance or amounting to five dollars or over.

TOOLS a plenty

But . . . you know what it *also* takes to do a tough course in less than par. It takes skill, coordination, and experience in solving unusual problems—just as in prefabricating and installing high-pressure and high-temperature piping, the specialized field in which Mitchell service has proved so satisfactory to many top power and process plants. Ask us in.

W. K. MITCHELL & CO., INC.
2946 Ellsworth Street, PHILADELPHIA 46, PA.

WESTPORT JOINT
(PATENTED)

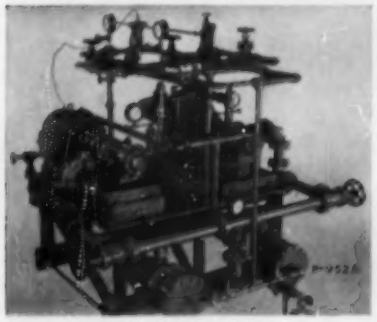
MITCHELL PIPING
SINCE 1899

PIPING FABRICATORS AND CONTRACTORS

NATIONAL AIROIL

SERVING INDUSTRY'S COMBUSTION REQUIREMENTS FOR 43 YEARS

NATIONAL AIROIL
FUEL OIL PUMPING and HEATING UNITS



P-952A—Steam Turbine and Electric Motor drive gives flexibility in this compact Model P-ES2H size No. 25 unit.

Complete range of sizes and models in both medium and high pressure types . . . more compact than ever! Write for Bulletin 40.

NATIONAL AIROIL
COMBUSTION ACCESSORIES

AIR CONTROL DOOR and FRAME

FUEL-OIL SUCTION STRAINER

WIDE VIEW PEEPHOLE

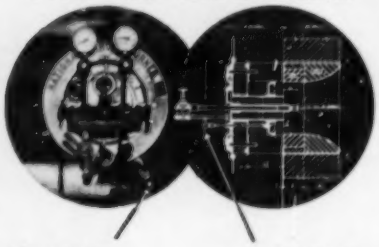
IGNITION PORT

FURNACE RELIEF and ACCESS DOOR

FUEL-OIL HEATER

These and other "accessory items" for every industrial liquid fuel-gas installation. Ask for Brochure No. 10.

NATIONAL AIROIL
UNIVERSAL REGISTERS with TYPE "SA" OIL BURNERS



Control for Air Vane — Control for Refractory Faced Disk

BETTER PERFORMANCE with NATIONAL AIROIL Universal Registers because they have a DUAL FEATURE for controlling air volume independent of turbulence. Air vanes can be instantly reversed to change direction of turbulence while air volume is separately regulated by a refractory faced disc control. Both adjustments can be made while the burner is firing. Another "dual advantage" of NATIONAL AIROIL Universal Registers is that they are equipped for dual fuel firing of gas and oil. Universal Registers with burners are available in three (3) sizes . . . capacities up to 60,000 lbs. of steam produced per burner per hour. Write for Bulletin #51.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes
STEAM ATOMIZING OIL BURNERS
SLUDGE BURNERS, Steam Atomizing
MOTOR-DRIVEN ROTARY OIL BURNERS
MECHANICAL PRESSURE ATOMIZING OIL BURNERS
DUAL STAGE, Combining Steam and Mechanical Atomization
LOW AIR PRESSURE OIL BURNERS
AUTOMATIC OIL BURNERS, for small process furnaces and heating plants
GAS BURNERS
COMBINATION GAS & OIL BURNERS
FUEL OIL PUMPING and HEATING UNITS
FURNACE RELIEF DOORS
OBSERVATION PORTS
SPECIAL REFRACTORY SHAPES

NATIONAL AIROIL BURNER CO., INC.

1310 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.

Southwestern Division: 2512 South Boulevard, Houston 6, Texas

INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

Advertisers' Index

Aerotec Corporation, The . . . . . *
Air Preheater Corporation, The 3
Allis-Chalmers Mfg. Company, Tractor Division 18
American Blower Corporation . . . . . 22 and 23
American Brake Shoe Company 64
Arabol Mfg. Co. . . . . *
Armstrong Machine Works . . . . *

Bailey Meter Company 46
Baltimore & Ohio Railroad . . . . *
Barrows Porcelain Enamel Co. . 67
C. O. Bartlett & Snow Company, The 27
Bayer Company, The 82
Beaumont Birch Company 65
Blaw-Knox Company, Blaw-Knox Equipment Div. 62
Buell Engineering Company, Inc. 54
Buffalo Forge Company 32

Cambridge Instrument Company . . . . . *
Carborundum Company, The . 30
Chain Belt Company 24
Chesapeake & Ohio Railway . . . 13
Clarage Fan Company . . . . . *
Cochrane Corporation . . . . . *
Coen Company . . . . . *
Combustion Control Division, Electronics Corporation of America . . . . . *
Combustion Engineering, Inc. . . . . Second Cover, 16 and 17
Combustion Publishing Company, Inc. 74
Copes-Vulcan Division, Continental Foundry & Machine Company . . . . . 36 and 37
Crane Co. 4
Crosby Steam Gage & Valve Company 26

Dampney Company, The 70
Dearborn Chemical Company . 31
De Laval Steam Turbine Company . . . . . *
Diamond Power Specialty Corporation . . . . . Third Cover
Dowell Incorporated 15

Eastern Gas & Fuel Associates . *
Economy Pumps, Inc. 86
Edward Valves, Inc. . . . . *
Engineer Company, The . . . . . *
Enos Coal Mining Company, The . . . . . *
Ernst Water Column & Gage Company . . . . . 70 and 73
Euclid Division, General Motors Corporation . . . . . *

Fairmont Coal Bureau 73
Flexitallic Gasket Company . . . 38
Foster Engineering Company . . 71

General Electric Company . . . . *
General Refractories Company 25
Gerotor May Corporation 72
Gifford-Wood Co. 20

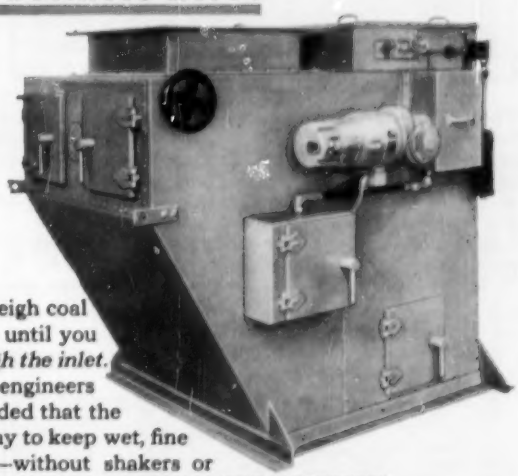
(Continued on page 85)

Graver Water Conditioning Company	6
Green Fuel Economizer Company, Inc.	*
Hagan Corporation	12
Hall Laboratories, Inc.	12
Haskins-Turner Co.	*
Hays Corporation, The	10 and 11
Ingersoll-Rand Company	*
Johns-Manville	9
M. W. Kellogg Company, The	7
Koppers Company, Inc.	*
Lukens Steel Company	14
Lummus Company, The	28
Manning, Maxwell & Moore Inc.	*
W. K. Mitchell & Company	83
National Airoil Burner Co., Inc.	84
National Aluminate Corporation	33 and 34
National Coal Association	2
Old Ben Coal Corporation	*
Olin Mathieson Chemical Corporation	21
Pacific Pumps, Inc.	*
Peabody Engineering Corporation	*
Pittsburgh Piping & Equipment Company	*
Poole Foundry & Machine Company	53
Powell Valves	*
Prat-Daniel Corporation	*
Radio Corporation of America	*
Refractory & Insulation Corporation	68
Reliance Gauge Column Company	66
Republic Flow Meters Company	*
Research-Cottrell, Inc.	8
Richardson Scale Company	85
Benjamin F. Shaw Company	Fourth Cover
Standard Tube Company, The	*
Stock Equipment Company	29
Sy-Co Corporation	*
W. A. Taylor and Co.	69
Thermix Corporation, The	5
Todd Shipyards Corp., Products Div.	71
United States Rubber Company	*
Walworth Company	58
Western Precipitation Corporation	*
Westinghouse Electric Corporation, Sturtevant Division	35
C. H. Wheeler Manufacturing Company	86
Yarnall-Waring Company	19

the hourglass shape...

...it may have been fine for Fannie,

but it has no business here!



You can't weigh coal in *any* scale until you *get it through the inlet.* Richardson engineers have concluded that the only sure way to keep wet, fine coal flowing—without shakers or vibrators—is to make that inlet BIG ENOUGH. So they opened up the "wasp waist" to a full 24″ x 24″, and around it they built the best coal scale it was possible to develop from fifty years' experience, the Richardson H-39.

If you're interested in maximum coal scale *efficiency* at wholly reasonable cost, specify a 24″ x 24″ minimum, and *know* that your coal will flow. That is the starting point from which the H-39 is soundly engineered in every feature, every detail. It's built as a coal scale *should* be, from the inside out, with a full 4 square feet of inlet. Get all the details, mechanical specifications, and drawings in Bulletin 0352.

Richardson

MATERIALS HANDLING BY WEIGHT SINCE 1901

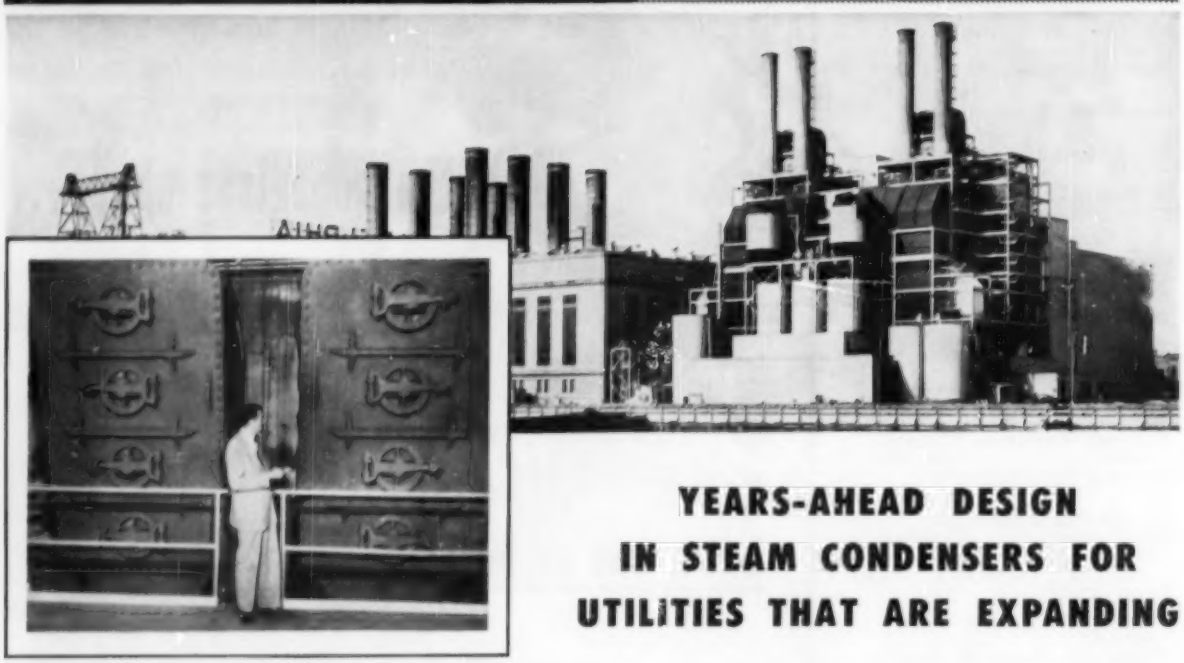
RICHARDSON SCALE COMPANY

Clifton, New Jersey

Atlanta • Boston • Buffalo • Chicago
Detroit • Houston • Memphis • Minneapolis
New York • Omaha • Philadelphia • Pittsburgh • San Francisco • Wichita • Montreal
Toronto • San Juan • Havana • Mexico City

IDEAS FOR ENGINEERS

FROM C.H. Wheeler OF PHILADELPHIA



YEARS-AHEAD DESIGN IN STEAM CONDENSERS FOR UTILITIES THAT ARE EXPANDING

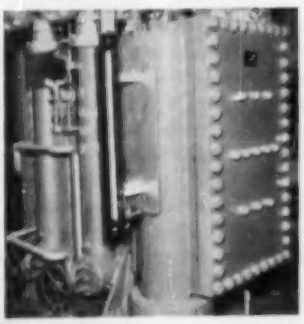
The Philadelphia Electric Company, for example, is one of the fastest growing utilities in the U. S. Here, men are thinking and working years ahead to take care of the "exploding" growth of the industrial Delaware Valley, and the ever-increasing population of Philadelphia, the "City of Homes". Nothing short of the most advanced design and efficiency of new equipment can be considered by the Philadelphia Electric Company to keep its generating capacity safely ahead of loading.

As part of their expansion program, two C. H. Wheeler 60,000 sq. ft. steam condensers are installed at the new Delaware Station. These are surface condensers of modern design; dual bank, single pass, divided water box type. Each unit condenses steam for a 125,000-kilowatt turbo-generator. Photo shows close-up of water box and manhole detail.

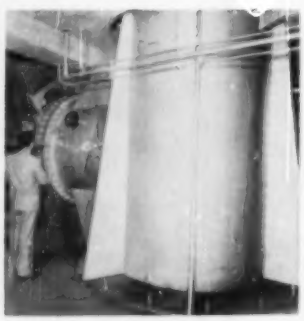
MAIN AIR EJECTORS ..by C. H. WHEELER

An important factor in the performance of the C. H. Wheeler Steam Condensers is the efficiency of the main air ejectors. C. H. Wheeler has always been the source for the latest developments in steam jet air ejectors.

The streamlined, steel-shell Tubejet Ejectors installed at the Delaware Station are effecting considerable savings in space and providing dependable removal of air.



HUGE C. H. WHEELER PUMPS DELIVER 86,500 GPM RIVER WATER



Other modern C. H. Wheeler installations at the new Delaware Station are the circulator pumps. C. H. Wheeler has closely integrated circulator pump design with modern steam generating demands. Pictured here is one of two vertical mixed flow circulating water pumps feeding Delaware River water to the new C. H. Wheeler Steam Condenser. Capacity of each pump is 86,500 GPM.

Bulletins mailed on request.

Inquiries receive prompt attention.

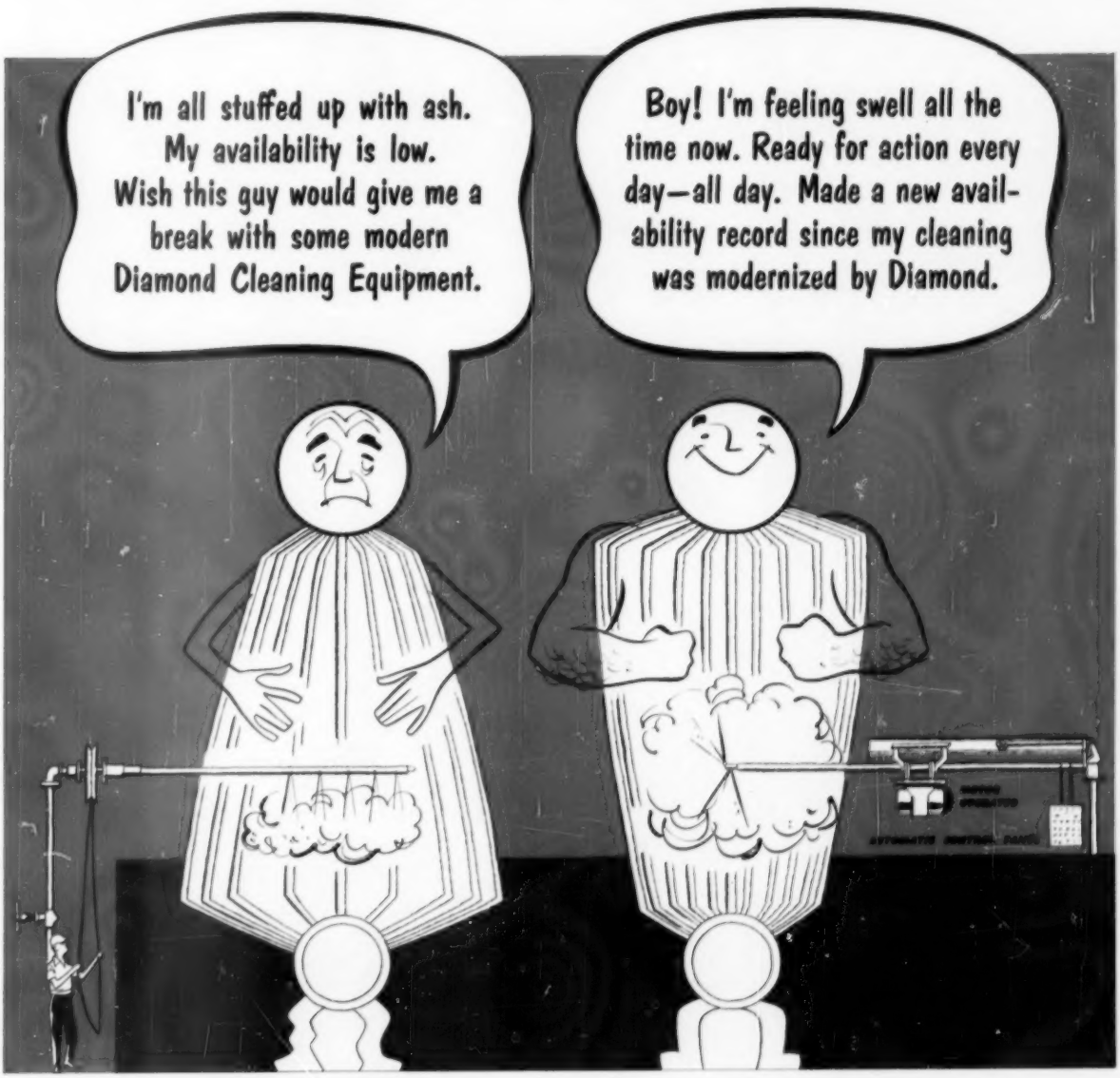
Representatives in principal cities.

C.H. Wheeler OF PHILADELPHIA

C. H. WHEELER MANUFACTURING CO., 19TH & LEHIGH, PHILA. 32, PENNA.

STEAM CONDENSERS · CENTRIFUGAL, AXIAL AND MIXED FLOW PUMPS · STEAM JET EJECTORS · VACUUM REFRIGERATION · HIGH VACUUM PROCESS EQUIPMENT
MARINE CONDENSERS AND EJECTORS · MARINE PUMPS · DECK MACHINERY

Modernize Boiler Cleaning to IMPROVE AVAILABILITY


I'm all stuffed up with ash. My availability is low. Wish this guy would give me a break with some modern Diamond Cleaning Equipment.
Boy! I'm feeling swell all the time now. Ready for action every day—all day. Made a new availability record since my cleaning was modernized by Diamond.

DIAMOND POWER SPECIALTY CORPORATION

LANCASTER, OHIO

DIAMOND SPECIALTY LIMITED, WINDSOR, ONTARIO

7205

Pioneering: an old story to Shaw

Philip Sporn, president of the American Gas and Electric Company, whose planning, leadership and vision have made the history-making project at Philo a reality.

History is in the making at the Philo Plant of the Ohio Power Company . . . where a pioneering project of tremendous importance is under way. Now under construction at Philo—one of the major plants of the American Gas and Electric Company System—is Unit 6, the first commercial steam electric generating installation to utilize steam *above* the critical pressure of 3,206 pounds per square inch. The world's most efficient unit, its steam generator will deliver steam at 4,500 p.s.i. pressure and 1,150° F. temperature to the turbine. The turbine will be the first to use steam reheated twice during its passage through the unit. Because of Shaw's world-wide reputation for careful planning, diversified experience, skillful fabrication and dependable, economical installation, they were chosen to fabricate and install the piping for this pioneering project. Pioneering is an old story to Shaw, for as far back as 1929, in a plant built by American Gas and Electric Company at Deepwater, New Jersey, Shaw fabricated and installed piping designed for 1,500 p.s.i. pressure—as history-making then as 4,500 p.s.i. is today. However challenging *your* piping problem, you can depend on Shaw for the right answer.

BENJAMIN F. shaw COMPANY

Main Offices and Plant: Wilmington, Delaware • Since 1893